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HILL AFB, UTAH
INSTALLATION RESTORATION PROGRAM
PHASE IIB IRP SURVEY
FINAL REPORT

VOLUME I: TEXT

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EXECUTIVE SUMMARY

This report presents the results of the Phase II hydrogeologic survey at Hill Air Force Base (AFB), Utah which was accomplished under the U.S. Air Force Installation Restoration Program (IRP).

The IRP Phase II Field Survey was conducted after the completion of an IRP Phase I Records Search by Engineering Science (1982). Thirteen disposal sites at Hill AFB were evaluated which were rated and prioritized by contamination potential. Of these sites, the U.S. Air Force selected the four highest priority waste disposal areas for initial Phase II investigation. The four waste areas selected were: (1) Chemical Disposal Pits No. 1 & 2, (2) Landfill No. 3, (3) Berman Pond, and (4) Chemical Disposal Pit No. 3.

The project team consisted of personnel from three organizations. The Utah Biomedical Test Laboratory (UBTL) Division of the University of Utah Research Institute (UURI) provided the overall project management and laboratory analyses. Radian Corporation conducted the field hydrogeological investigation and interpretation of conditions. The Earth Science Laboratory (ESL) of UURI provided geophysical surveys of the waste sites.

The report is presented in two volumes. Volume I is the text of the final report and Volume II contains appendices supporting the investigation.

Location of Sites

Five separate areas were investigated during this study. They are: Chemical Disposal Pits Nos. 1 & 2, Landfill No. 3, Hill AFB Golf Course Area, Berman Pond, Chemical Disposal Pit No. 3. The general locations of these areas are shown on Figure S-1. The Golf Course area was included by the IRP Phase II team in order to examine potential groundwater recharge to the down slope waste sites at the Chemical Disposal Pits No. 1 & 2 and Landfill No. 3 areas.

Chemical Disposal Pits No. 1 & 2

Chemical Disposal Pits No. 1 & 2, located in the eastern portion of the base (Figure S-1) were used for dumping of liquid petroleum wastes from 1954 to 1973. The liquids were periodically burned. Oil has been detected on top of groundwater in two monitor wells located 200 to 300 feet from the pits. Previous chemical analyses of water samples showed high levels of COD, BOD and phenols. (U.S. Air Force Occupational and Environmental Health Laboratory, 1976)

Landfill No. 3

Landfill No. 3 (Figure S-1) was operated from 1947 through 1967. Large quantities of waste solvents, bottoms from solvent cleaning operations, and sludge from the base Industrial Wastewater Treatment Plant (IWTP) were placed in the landfill. The proximity of Landfill No. 3 to a previously studied Landfill No. 4 (Calscience Research, Inc., 1981; and U.S. Air Force Occupational and Environmental Health Laboratory, 1976) suggested that it may be contributing to the contamination observed near Landfill No. 4. Northwest of Landfill No. 3 is a fire protection training area. Although this area was not part of the present study, some data were indirectly developed for that area in the course of the Landfill No. 3 studies.

Golf Course Area

Construction of an 18-hole golf course on the east side of the base began in 1960 (Figure S-1). The facility is equipped with an irrigation system. The golf course is situated south of the waste disposal areas of Chemical Disposal Pits No. 1 & 2, Landfill Nos. 3 & 4 and is topographically about 50 feet higher than the disposal areas. The golf course is not a waste disposal area. As noted above, it was included in the survey by the IRP Phase II team in order to assess its hydrologic effect upon the down slope disposal areas.

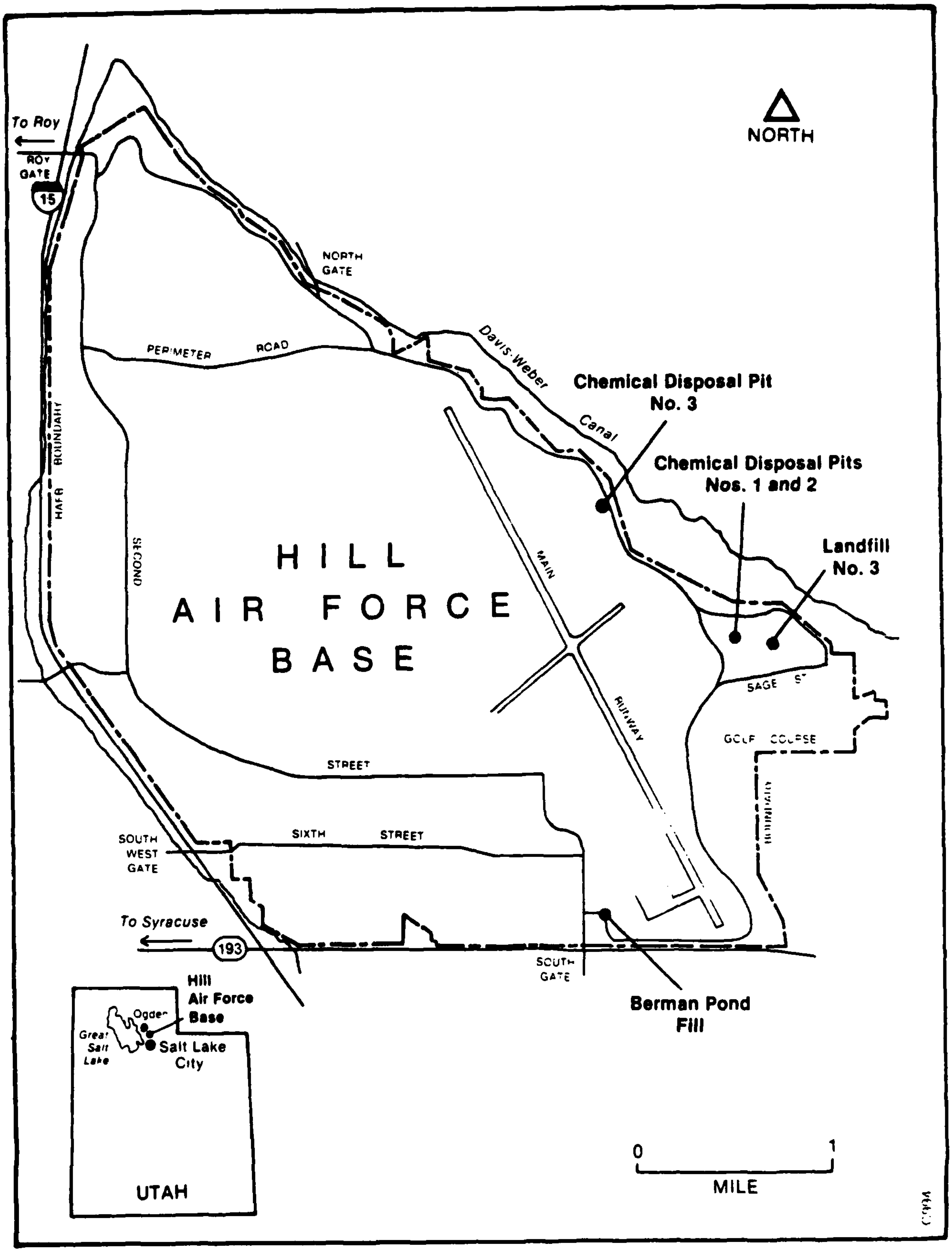

Figure S-1. Study Area and Waste Site Locations.

Berman Pond

Berman Pond was operated as an unlined evaporation pond for industrial wastewaters, including electroplating wastes, from 1940 to 1956. The site, located at the southern end of the base, has been filled and regraded (Figure S-1). No site-specific data on the subsurface geology and groundwater in the Berman Pond area were available prior to this investigation.

Chemical Disposal Pit No. 3

Chemical Disposal Pit No. 3, located on the northeastern border of Hill AFB (Figure S-1), was used from 1967 to 1975 for disposal of large quantities of sludges bottoms from a TCE solvent recovery unit. The area is also reported to have received bottoms from plating operations during the 1940's. The exact location of the pit was not evident. No studies had been performed in the area, and no evidence of contaminant discharge off-base from the pit has been reported.

Type and Number of Tests Conducted

A variety of techniques were employed in the Hill AFB Survey. They include three geophysical techniques (electrical resistivity, ground magnetics and self-potential measurements), soil coring and analysis as well as sampling for water analysis from monitor wells, lysimeters and piezometers installed as part of the project. In addition, water samples were collected from selected existing monitor wells. Table S-1 summarizes the field program and sampling. Table S-2 summarizes the pollutant analyses.

Based upon the IRP Phase II Field Survey findings, the following results can be derived.

Geophysical Results

Chemical Disposal Pits No. 1 & 2. Resistivity data have mapped a rather continuous clay layer at depths between 30 and 50 feet, beneath Chemical Pits No. 1 & 2, in contrast to much thicker sand and gravels to the west and north which could permit migration to the west and north of pollutants from the chemical pits. Ground magnetic data mapped a broad

Table S-1

Summary of Field Program Techniques and Sampling Methods

	Data Review	Electrical Resistivity	Ground Magnetics	Self-Potential	Soil Coring	Monitor Wells	Piezometers	Lysimeters
Chemical Disposal Pits Nos. 1 & 2	X	X	X	X	X	X		
Landfill No. 3	X	X	X			X		
Golf Course Area	X	X				X		
Berman Pond	X	X	X		X	X		X
Chemical Disposal Pit No. 3	X	X		X	X		X	X

Table S-2.

Summary of Pollutant Analyses - Ranges Detected

Water Analysis	Chem. Pits Nos. 1 & 2	Landfill No. 3	Golf Course Area	Berman Pond	Chem. Pit No. 3	Units
TOC	2-15	1-14	2-3	2-18	4-190	mg/L
TOX	90-950	30-280	70	60-2,800	40-180,000	µg/L
Oil & Grease	<5-76	<5	<5-6	<5		mg/L
Phenol	<10-1,200	<10-50	70-390	<10-30	<10-15,300	µg/L
MBAS		<0.1-0.4	<0.1-0.2			mg/L
TDS	340-840	320-2900	80-1,000			mg/L
Cyanide		<10	<10	<10	<10	µg/L
Sulfate	<5-45	21-480	8-130			mg/L
Arsenic		<5-28	<5-<10			µg/L
Barium	<100	<100	<100	<100	<100	µg/L
Beryllium		<10	<10	<10	<10	µg/L
Cadmium	<10-10	<10-20	<10	<10	<10-100	µg/L
Chromium		<50	<50	<50	<50	µg/L
Copper		<20	<20			µg/L
Iron	<100-18,000	<100-2,100	<100-200	<100	<100	µg/L
Lead		<10-<20	<10-<20			µg/L
Manganese	140-1,600	<20-1,700	<20-440	<20-70	<20-2,400	µg/L
Mercury		<0.2-<10	<0.2-<10			µg/L
Zinc	200-320	30-90	30-230	<10-40	<10-540	µg/L
601 (1)	<1-34,000	<1-490	<1	<1-1,400	<1-610,000	µg/L
602 (2)	<1-25,000	<1-37	<1-3	<1-2		µg/L
GC/MS (3)						
ICAP (4)						
Conductance	580-1,300	390-4500	100-1,800	250-840	80-3,300	µmho/cm
Calcium	52-180	50-300	10-100	18-110	13-280	mg/L
Magnesium	26-31	12-130	1-51	7-14	9-130	mg/L
Sodium	27-49	38-490	13-200			mg/L
Potassium	4-8	2-19	<1-26			mg/L
Carbonate	18-44	<1-68	10-52			mg/L
Bicarbonate	200-520	220-530	20-470			mg/L
Chloride	50-79	48,1,000	14,230			mg/L
Fluoride	0.2-0.3	0.3-0.5	0.2-1.3			mg/L
Nitrate	<0.02-0.61	<0.02-3.3	0.5-5.4			mg/L
Hardness	250-580	240-1,300	29-420			mg/L
Silica	11-29	10-18	2-16			mg/L

(1) Volatile halocarbons
(2) Volatile aromatics
(3) GC/MS screening for organics, see test for details
(4) ICP screening for metals, see test for details

Table S-2. (Continued)

Summary of Pollutant Analyses - Ranges Detected

Water Analysis	Chem. Pits Nos. 1 & 2	Landfill No. 3	Golf Course Area	Berman Pond	Chem. Pit No. 3	Units
TOC	3,000-23,000			630,6,000	470-18,000	ug/L
TOX	<5-11			>5->6	>5->6	ug/L
Oil & Grease	<5-370			<5-12		mg/L
Phenol	<10-380			<10-43		ug/L
Cyanide				<10-<11	<10-<13	ug/L
Beryllium				<4	>4-49	ug/L
Cadmium				<4-17	<4-510	ug/L
Chromium				<20-230	<20-270	ug/L
Moisture	1.5-19			2.1-9.1	2-22	%

area (200 by 400+ feet) of metal trash and debris which includes the two pits. Erratic self-potential values suggest electrochemical reactions are continuing within the soil in the disturbed area mapped by the magnetics. The differential oxidation of iron barrels and other metallic trash in contact with near surface waters is the most likely source of the erratic voltage measurements.

Landfill No. 3. Electrical resistivity data indicate clay and sandy clay generally less than 30 feet deep beneath the eastern 70% of Landfill No. 3. Higher resistivities (75 ohm-meters) south of the top-of-slope indicate clay layers are more than 60 feet deep. Ground magnetic data indicate the presence of fill and magnetic trash throughout the Landfill No. 3 area.

Golf Course Area. One resistivity line suggests that a clay layer is present at shallow (10-30 feet) depth beneath much of the Golf Course Area. At Base Well No. 4, near the intersection of Sage Street and Perimeter Road, the clay layer appears to be deeper (30 feet or more) and dipping to the north.

Berman Pond. The Berman Pond fill is indicated by apparent resistivities less than 100 ohm-meters in contrast to much higher values (200 to 1000 ohm-meters) corresponding to undisturbed sands to the south. No substantial (5 feet thick or more) laterally extensive clay layer is present within 60-80 feet of the surface at Berman Pond. Ground magnetic survey data confirm the presence of much magnetic debris within the fill and further substantiate the outline of the landfill area.

Chemical Disposal Pit No. 3. Five dipole-dipole resistivity lines defined a complex resistivity distribution at Chemical Disposal Pit No. 3 which was interpreted to be a major slump feature. Clay layers are present west of the pits, but are broken and discontinuous within the slump block. Multiple pathways for contaminant migration thus appear to be present at this site.

Hydrogeologic Results

Chemical Disposal Pits No. 1 & 2 and Chemical Disposal Pit No. 3 have affected the largest downgradient groundwater areas by past disposal activities at the Base. Their disposal areas are much smaller than Landfill No. 3. No shallow groundwater was encountered at Berman Pond. Follow-on investigations will be required to fully evaluate the extent of contamination.

In the case of Chemical Disposal Pit No. 3, the approximate lateral extent of downgradient groundwater impact could encompass 14 acres between the Base boundary and the Davis Weber Canal. Migration east of the canal is a possibility because it is also located on a slump complex. The volume of groundwater impacted could not be reliably computed due to the numerous pathways for potential contaminant migration through the slump feature and the absence of downgradient hydrogeologic data. The thicknesses of the flow paths in the aquifers at the pit range from fractions of a millimeter along the slump fault planes to greater than 23 feet in the sand zones, with significant changes over short distances.

Contaminated soil outside Chemical Disposal Pits No. 1 & 2 was due to waste fluids migrating along the top of the groundwater surface, as evidenced by oil slicks at two nearby monitor wells (W-4 and 80-20) to the west. The lateral extent and thickness of the oil slick is unknown. The migration of the waste products from the pits is primarily to the nortwest with a probably secondary component to the north. The main groundwater flow goes to the Northwest.

Conclusions and Recommendations

The objectives of the initial IRP Phase II Field Investigation were met and information gaps identified. During the course of the investigation, it was found that a variety of hydrogeological conditions exist at the Base. All of the sites tasked for investigation were located and contamination was detected in groundwater in the vicinity of most of the waste sites. The Base Golf Course Area was investigated to determine its potential hydrologic impact on nearby Landfill No. 3 and Chemical Disposal

Pit Nos. 1 and 2. General site conclusions and recommendations are provided for each area as follows on Table S-3. Additionally, preliminary information on Landfill No. 4 (located next to Landfill No. 3) was developed during this study and warrants a brief comment in Table S-3.

Table S-3. Hill AFB IRP Phase II Investigation General Site Status

1. Chemical Disposal Pits Nos. 1&2: The sites were located and a plume was identified. The plume was also found to extend beyond the area of current monitor well control. Local hydrogeologic conditions were defined to include an underlying shallow clay and the identification of an aquifer under the clay. Downgradient and off-site conditions beyond present data are unknown. Field investigations will be required to define the plume and downgradient hydrogeologic conditions. Any remedial action design would have to consider the present sites and plume identified.

2. Landfill No. 3: A contamination plume was detected but not completely defined downgradient of the landfill. *The local hydrogeology has been defined to* include the underlying clay and the identification of an aquifer under the clay. Field investigations will be required to define the plume downgradient.

3. Golf Course: Groundwater was found below the golf course which can contribute groundwater underflow to the topographically lower disposal areas. Available information suggests that any remedial action at the topographically lower disposal areas should address the effects of groundwater underflow.

4. Landfill No. 4: Some monitor wells installed prior to this investigation are believed to be screened across the shallow and lower aquifers; in addition, some of these wells with either partial construction and/or entire casing are perforated. Therefore, it is recommended that the well construction data and screened horizons be evaluated to assess the usefulness of these wells as monitor wells under the remedial actions program. This assessment would also include the identification of locations of other monitor wells.

5. Berman Pond. Based upon present data, the approximate areal extent of the pond has been identified, local hydrogeology has been determined and the absence of shallow perched groundwater has been confirmed. Two deep aquifers at depths greater than 90 feet were found. If leachate is being generated at the pond, it would not be the result of groundwater intrusions but would be predominantly from infiltration of precipitation and possible leakage from utility water lines. Chemical analyses from the shallow lysimeters and deep monitor wells indicate contamination in groundwater, but due to the complexity of hydrogeologic conditions, the impact of Berman Pond on the groundwater is uncertain and cannot be reliably stated. Additional field investigation would be needed to define any impact on the local groundwater systems and assesses the potential for continued generation of leachate from the pond area.

6. Chemical Disposal Pit No. 3: Disposal pit location was determined. The local hydrogeology was determined and the occurrence of solvents in a perched shallow groundwater system was detected. Additional solvents were detected upgradient of the pit(s). The source of these solvents is unknown. Downgradient and off-site conditions are unknown. *Additional field investigation is* recommended to identify other source(s) of solvents and to assess the extent of impacts.

1.0 INTRODUCTION

1.1 Purpose of Program

The purpose of this program was to determine if environmental contamination has resulted from waste disposal practices at Hill Air Force Base (AFB), Utah. The University of Utah Research Institute (UURI) was retained in September, 1982, to conduct a field evaluation at Hill AFB under Phase II of the Department of Defense Installation Restoration Program. The objectives were:

1) To determine whether hazardous materials were present in the surface and subsurface environments.
2) To determine whether the hazardous materials, if present, were migrating or had the potential to migrate.
3) To recommend actions necessary to evaluate the magnitude and extent of contamination should contamination be found.
4) To suggest an environmental monitoring program as needed to document current conditions and future discharges.

The complete Description of Work is presented in Appendix B of this report.

The survey was designed by the field team to make maximum use of the data as it was produced in order to refine the direction of the survey as it progressed. The purpose of this approach was to allow the reallocation of resources from sites not requiring the level of effort initially anticipated to sites found to require a more extensive characterization of contamination.

1.2. Duration of Program

The presurvey meeting was held at Hill AFB on 2 August 1982. The Phase II presurvey report was submitted on 1 September 1982. Work began at Hill AFB in mid-October 1982. The scheduled field work concluded with the second round of water samples collected in early May 1983 and with the final well measurements made in late May 1983. After the scheduled field

work was completed, Hill AFB personnel performed the surveying required to tie in the sampling points. That data was relayed to the project team in June and July of 1983.

The final measurements of depth-to-water and of oil thickness in the area of Chemical Disposal Pits Nos. 1 & 2 at Hill AFB showed an unusual pattern. The field team proposed that an additional set of such measurements be made through the summer and fall of 1983. The proposal was accepted by the United States Air Force. The additional measurements of depth-to-water and oil thickness were completed in mid-November 1983.

1.3 History

The history of Hill Air Force Base with an emphasis upon activities which may have had an impact upon hazardous waste generation has been reviewed in the Phase I Records Search Report (Engineering-Science, 1982). The following summary information is excerpted from that report.

1.3.1 Installation History

Hill Field was commissioned in November, 1940. In 1952, the Air Material Command made Hill AFB the prime depot for the F-89 Scorpion. In 1959, Hill AFB became the logistics manager of the Minuteman missile; and in 1965, was assigned complete logistics management for the Minuteman missile force. In 1968, Hill AFB became manager for the Maverick missile and assumed responsibility of the Air Force Logistics Command Test Range. A SAC satellite base was established at Hill AFB from 1973 to 1975. In 1979, Hill AFB assumed worldwide management of the F-16.

1.3.2 Current Organization and Mission

The Ogden Air Logistics Center (ALC) is the major organization at Hill AFB. It is one of five air logistics centers which comprises the Air Force Logistics Command (AFLC) with headquarters at Wright-Patterson AFB, Ohio. AFLC has the mission objective of ensuring that Air Force weapon systems are kept at maximum operational capability at least possible cost. AFLC provides the supplies, material and services necessary to maintain the Air Force in a constant combat-ready posture.

The Ogden Air Logistics Center has five major groups, which may impact on hazardous waste generation. They are:

- Directorate of Maintenance
- Directorate of Distribution
- Directorate of Material Management
- Directorate of Contracting and Manufacturing
- Commander-2849th Air Base Group (ABG)

The major tenant units at Hill AFB are: the 388th Tactical Fighter Wing, the 6545th Test Group, the 1954th Radar Evaluation Squadron, the 1881st Communication Squadron, the 533rd Field Training Detachment, and the 419th Tactical Fighter Wing.

1.3.3 Hazardous Waste Generating Activities

Most hazardous wastes generated at Hill AFB can be associated with one of the following five activities carried out on the base:

- Industrial Operations (Shops)
- Pesticide and Herbicide Utilization
- Fire Control Training
- Hazardous Waste Storage
- Fuels Management

1.3.4 Waste Management Facilities

The facilities on the base which have been used for the management of waste can be categorized as follows:

- Landfills
- Chemical Disposal Pits
- Wastewater Treatment Plants
- Evaporation Ponds
- Septic Tanks
- Storm, Industrial, and Sanitary Sewers

1.3.5 Phase I Records Search

A review of past and present waste generation sources at Hill AFB was conducted. Past and present waste materials were identified and the disposal methods used for each source were determined according to base records on interviews.

Potentially contaminated sites were assessed using a rating system which took into account the following factors:

- Receptors
- Pathways
- Waste Characteristics
- Waste Management Practices

Thirteen areas were identified as warranting further evaluation under Phase II.

1.3.6 Presurvey

A presurvey meeting was held at Hill AFB on 2 August 1982 to define the scope of the initial Phase II effort. The recommendations of the Phase I Records Search were reviewed. Nine of the thirteen areas noted in the Phase I report were inspected. Ultimately four sites were identified by the U.S. Air Force as requiring evaluation under the initial Phase II survey.

1.4 Description of Sites

Five separate areas were investigated during this study. They are: Chemical Disposal Pits Nos. 1 & 2, Landfill No. 3, Hill AFB Golf Course Area, Berman Pond, Chemical Disposal Pit No. 3. The general locations of these areas are shown on Figure 1-1. The Golf Course area was included by the IRP Phase II team in order to examine potential groundwater recharge to the down slope waste sites at chemical Disposal Pits Nos. 1 & 2 and Landfill No. 3 areas. The Fire Training Pit at Hill AFB is located within the area of Chemical Disposal Pits No. 1 & 2 and Landfill No. 3. Although this site was not specifically referenced in the Phase II Statement of

Work, the Fire Training Pit was indirectly monitored during the survey because of its proximity to the other sites. The following brief descriptions of the study sites are taken predominantly from the earlier Phase I records search (Engineering-Science, 1982).

1.4.1 Chemical Disposal Pits Nos. 1 & 2

Chemical Disposal Pits Nos. 1 & 2, located in the eastern portion of the base (Figure 1-1) were used for dumping of liquid petroleum wastes from 1954 to 1973. The liquids were periodically burned. Oil has been detected on top of groundwater in two monitor wells located about 200 to 300 feet away. Previous chemical analyses of water samples showed high levels of COD, BOD and phenols. (U.S. Air Force Occupational and Environmental Health Laboratory, 1976)

1.4.2 Landfill No. 3

Landfill No. 3 (Figure 1-1) was operated from 1947 through 1967. Large quantities of waste solvents, bottoms from solvent cleaning operations, and sludge from the base Industrial Wastewater Treatment Plant (IWTP) were placed in the landfill. The proximity of Landfill No. 3 to a previously studied Landfill No. 4 suggested that it may be contributing to the contamination observed near Landfill No. 4.

1.4.3 Golf Course Area

Construction of an 18-hole golf course on the east side of the base began in 1960 (Figure 1-1). The facility is equipped with an irrigation system. The golf course is situated south of the waste disposal areas of Chemical Disposal Pits Nos. 1 & 2, Landfill Nos. 3 & 4 and is topographically about 50 feet higher than the disposal areas. The golf course is not a waste disposal area. As noted above, it was included in the survey by the IRP Phase II team in order to assess its effect upon the down slope disposal areas.

1.4.4 Berman Pond

Berman Pond was operated as an unlined evaporation pond for industrial wastewaters, including electroplating wastes, from 1940 to 1956. The site, located at the southern end of the base, has been filled

and regraded (Figure 1-1). No site-specific data on the subsurface geology and groundwater in the Berman Pond area were available prior to this investigation.

1.4.5 Chemical Disposal Pit No. 3

Chemical Disposal Pit No. 3, located on the northeastern border of Hill AFB (Figure 1-1), was used from 1967 to 1975 for disposal of large quantities of TCE bottoms from a solvent recovery unit and vapor degreasers. The area is also reported to have received bottoms from plating operations during the 1940's. The exact location of the pit was not evident. No studies had been performed in the area, and no evidence of contaminant discharge off-base from the pit has been reported.

1.5 Field Program, Sampling and Pollutant Analyses

In this section, the field program and types of samples collected are summarized. The objectives for each approach are noted. The list of chemical analyses is summarized; and the rationale for the selection of the analyses is reviewed.

1.5.1 Field Program and Sampling

The field program began with a data review phase. Records, maps, well logs, etc. were obtained and reviewed to gather all available information pertinent to the survey. Subsequent activities were planned on the basis of this information.

Electrical resistivity surveys were recommended to determine the lateral extent and thickness of clay lenses and, if possible, the lateral extent of contamination plumes. Based upon findings from the data review phase, the geophysical program was redesigned to replace some of the electrical resistivity measurements with ground magnetic survey profiles and with self-potential surveys. The additional techniques were included to better define the disposal areas.

Soil coring samples were taken to define the extent of hazardous waste disposal sites of uncertain dimensions. In a few cases, additional analyses were performed on samples of soil resulting from the emplacement

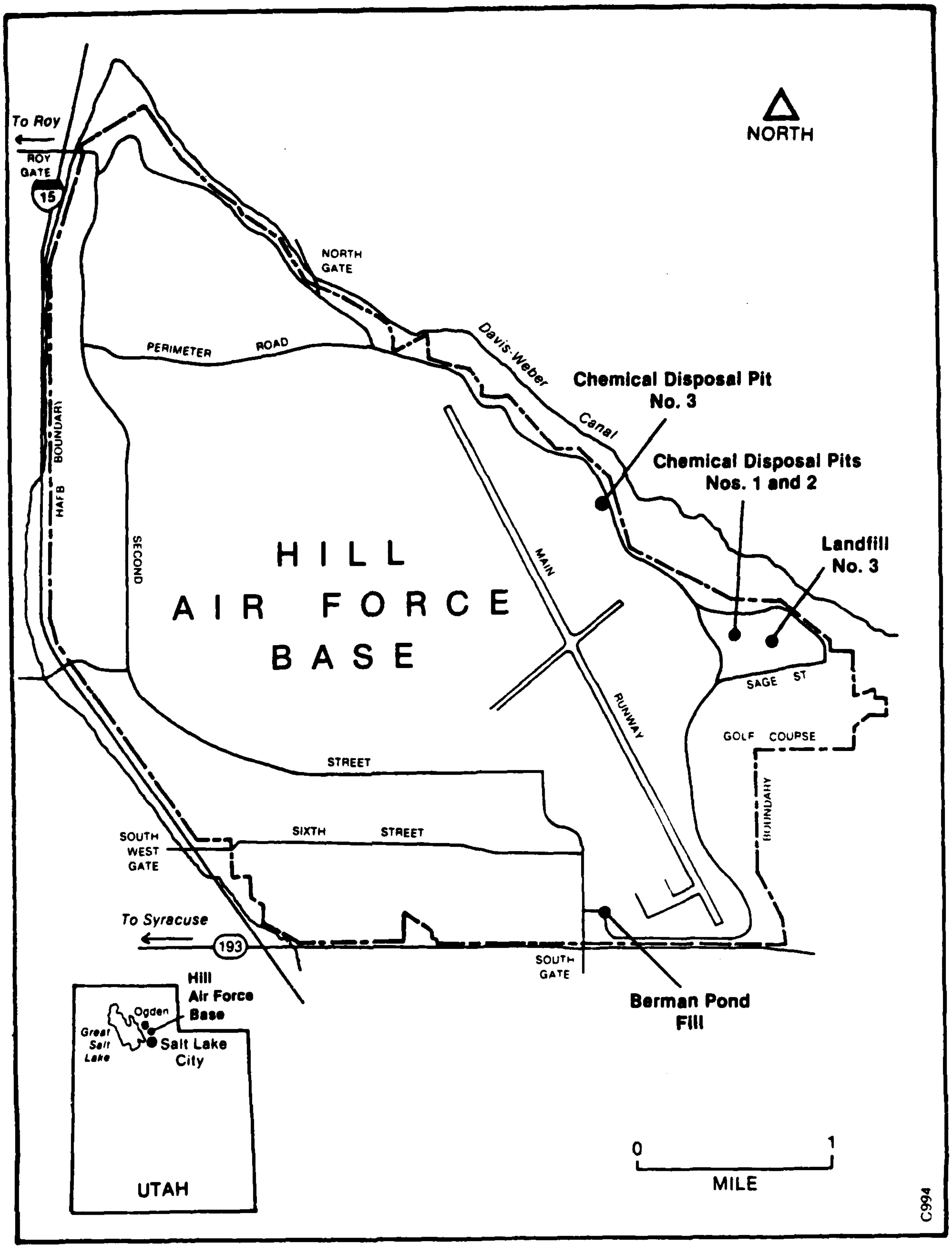

Figure 1-1. Study Area and Waste Site Locations.

of monitor wells, lysimeters or piezometers. These additional soil analyses provided information which was used to evaluate the nature and extent of contaminant migration.

Water samples of four types were collected for analysis. Samples from monitor wells and piezometers were taken in order to determine the nature and extent of contaminant migration. Samples from lysimeters were taken to assess the migration of contaminants in the vadose (unsaturated) zone at three of the sites. One surface water sample was taken to clarify recharge of the aquifer underlying Chemical Disposal Pits Nos. 1 & 2 and Landfill No. 3. A sample of water from Base Well No. 4 (a production well) was analyzed for the organic priority pollutants by GC/MS.

Water sampling was conducted in two rounds. The first round of samples was taken in the winter of 1982-83. The second round was taken in the spring of 1983. The purpose of the second round of water sampling was twofold. The second round of sampling allowed for the quantitative analysis of parameters identified by the screening analyses (GC/MS and ICP) which were performed as a part of the first round. The second round of sampling also allowed for an assessment of the effect of the spring runoff upon the waste disposal sites.

A summary of field program techniques and sampling methods is given in Table 1-1.

1.5.2 Pollutant Analyses

Based upon the results of the Phase I Records Search, a list of potential contaminants was compiled for each site. Water samples taken from a particular site were analyzed for all of the potential contaminants listed for the site. The soil samples were analyzed for a few of the contaminants considered most likely to be present, since the purpose of the soil sampling and analysis program was to precisely locate the waste disposal sites.

Based upon a review of the results of the first round of water sample analysis, additional analyses were specified for the second round of water samples.

Table 1-1

Summary of Field Program Techniques and Sampling Methods

	Data Review	Electrical Resistivity	Ground Magnetics	Self-Potential	Soil Coring	Monitor Wells	Piezometers	Lysimeters
Chemical Disposal Pits Nos. 1 & 2	X	X	X	X	X	X		
Landfill No. 3	X	X	X			X		
Golf Course Area	X	X				X		
Berman Pond	X	X	X		X	X		X
Chemical Disposal Pit No. 3	X	X		X	X		X	X

The number and type of pollutant analyses are summarized in Table 1-2. For each site the number of samples analyzed in Round I and Round II as well as the total number of samples analyzed are given for each parameter.

1.6 Identification of Field Team

1.6.1 Project Organization

The Phase II IRP Survey at Hill AFB involved several organizations. JRB Associates, with offices in McLean, Virginia, was the prime contractor to the U.S. Air Force. The UBTL Division of the University of Utah Research Institute (UURI) was a subcontractor to JRB Associates. UBTL had overall responsibility for the project in addition to responsibility for the chemical analyses. Radian Corporation, also a subcontractor to JRB Associates, was a subcontractor to UBTL for the Hill AFB Phase II Survey. The Salt Lake office of Radian Corporation was responsible for most aspects of the field work and, with the Austin office, for the interpretation of the results of the field work. The Earth Science Laboratory (ESL) of the University of Utah Research Institute was responsible for the geophysical work.

The organization of the project is illustrated in the following diagram. The field team is enclosed by dashed lines.

1.6.2 Field Team Responsibilities

In this section, the individuals responsible for specific project tasks are identified. Curricula vitae of key personnel are presented in Appendix I.

The UBTL Division of the University of Utah Research Institute was responsible for overall project management and for chemical analyses. Key personnel were:

Sim D. Lessley, Ph.D. - Project management, laboratory management, report preparation

A. Brent Torgensen - Inorganic chemical analyses

Edward H. Sanders, Ph.D. - Organic chemical analyses

Table 1-2.

Number and Type of Pollutant Analyses

Water Analysis	Chem. Pits Nos. 1 & 2 I	II	Total	Landfill No. 3 I	II	Total	Golf Course Area I	II	Total	Berman Pond I	II	Total	Chem. Pit No. 3 I	II	Total	Total Analyzed
TOC	4	4	8	6	6	12	1	1	2	5	5	10	11	13	24	56
TOX	4	0	4	6	0	6	1	0	1	5	0	5	11	0	11	27
Oil & Grease	4	4	8	5	6	11	1	1	2	3	3	6	0	0	0	27
Phenol	4	4	8	5	6	11	1	1	2	4	3	7	0	10	10	38
MBAS	0	0	0	6	6	12	1	1	2	0	0	0	0	0	0	14
TDS	2	2	4	7	6	13	1	5	6	0	0	0	0	0	0	23
Cyanide	0	0	0	5	6	11	1	1	2	3	3	6	11	12	23	42
Sulfate	2	2	4	8	6	14	1	5	6	0	0	0	0	0	0	24
Arsenic	0	0	0	5	6	11	1	1	2	0	0	0	0	0	0	13
Barium	0	4	4	0	6	6	0	5	5	0	5	5	0	13	13	33
Beryllium	0	0	0	5	6	11	1	1	2	5	5	10	11	13	24	47
Cadmium	0	4	4	5	6	11	1	4	5	5	5	10	11	13	24	54
Chromium	0	0	0	5	6	11	1	1	2	5	5	10	11	13	24	47
Copper	0	0	0	5	6	11	1	1	2	0	0	0	0	0	0	13
Iron	2	4	6	7	6	13	1	5	6	0	5	5	0	13	13	43
Lead	0	0	0	5	6	11	1	1	2	0	0	0	0	0	0	13
Manganese	2	4	6	7	6	13	1	5	6	0	5	5	0	13	13	43
Mercury	0	0	0	5	6	11	1	1	2	0	0	0	0	0	0	13
Zinc	0	4	4	0	6	6	0	5	5	0	5	5	0	13	13	33
601 (6 analytes)	4	0	4	6	0	6	1	0	1	5	0	5	11	0	11	27
601 (29 analytes)	0	4	4	0	6	6	0	1	1	0	4	4	0	13	13	28
602 (6 analytes)	4	4	8	6	6	12	1	1	2	4	4	8	0	0	0	30
GC/MS	1	0	1	2	0	2	0	0	0	2	0	2	0	0	0	6*
ICAP	1	0	1	2	0	2	0	0	0	2	0	2	0	0	0	5
Conductivity	4	4	8	5	6	11	1	5	6	2	5	7	11	13	24	56
Calcium	2	4	6	4	6	10	1	5	6	0	5	5	0	13	13	40
Magnesium	2	4	6	4	6	10	1	5	6	0	5	5	0	13	13	40
Sodium	2	2	4	4	4	8	1	5	6	0	0	0	0	0	0	18
Potassium	2	2	4	4	4	8	1	5	6	0	0	0	0	0	0	18
Carbonate	2	2	4	4	4	8	1	5	6	0	0	0	0	0	0	18
Bicarbonate	2	2	4	4	4	8	1	5	6	0	0	0	0	0	0	18
Chloride	2	2	4	4	4	8	1	5	6	0	0	0	0	0	0	18
Fluoride	2	2	4	4	4	8	1	5	6	0	0	0	0	0	0	18
Nitrate	2	2	4	4	4	8	1	5	6	0	0	0	0	0	0	18
rdness	2	2	4	4	4	8	1	5	6	0	0	0	0	0	0	18
Silica	2	2	4	4	4	8	1	5	6	0	0	0	0	0	0	18

*Note: An additional GC/MS sample from Base Well No. 4 was also processed.

Table 1-2. (continued)

Number and Type of Pollutant Analyses

Soil Analysis	Chem. Pits Nos. 1 & 2			Landfill No. 3			Golf Course Area			Berman Pond			Chem. Pit No. 3			Total Analyzed
	I	II	Total	I	II	Total	I	II	Total	I	II	Total	I	II	Total	
TOC	21	0	21	0	0	0	0	0	0	17	0	17	36	0	36	74
TOX	21	0	21	0	0	0	0	0	0	17	0	17	36	0	36	74
Oil & Grease	21	0	21	0	0	0	0	0	0	17	0	17	0	0	0	38
Phenol	0	0	0	0	0	0	0	0	0	17	0	17	0	0	0	38
Cyanide	0	0	0	0	0	0	0	0	0	17	0	17	36	0	36	53
Beryllium	0	0	0	0	0	0	0	0	0	17	0	17	36	0	36	53
Cadmium	0	0	0	0	0	0	0	0	0	17	0	17	36	0	36	53
Chromium	0	0	0	0	0	0	0	0	0	17	0	17	36	0	36	53
Moisture	21	0	21	0	0	0	0	0	0	17	0	17	36	0	36	74

Radian Corporation was responsible for all field work except the geophysical surveys. Radian Corporation was also responsible for interpretation of the field data. Key personnel were:

Rick A. Belan - Field management of survey, report preparation
Robert Vandervort - Radian Corporation program management
Ann E. St. Clair - Report preparation
William M. Little - Report preparation
Jerry L. Parr - Report preparation
Donald H. Rodgers - Report preparation
Fred B. Blood - Report preparation

The Earth Science Laboratory of the University of Utah Research Institute was responsible for the geophysical surveys. Key personnel were:

Howard P. Ross, Ph.D. - Geophysics, report preparation
Claron E. Mackelprang - Geophysics, report preparation

2.0 ENVIRONMENTAL SETTING

This section provides an overview of the general environmental setting of Hill AFB (Sections 2.1, 2.2), and then discusses the site-specific setting of the disposal sites evaluated in this study (Section 2.3). Section 2.4 provides a brief description of historic groundwater problems while Section 2.5 discusses the location of the wells and borings that formed the data base for this study.

2.1 Physical Geography and Setting

Hill Air Force Base (AFB) is located in northern Utah approximately 25 miles north of Salt Lake City and approximately 5 miles south of Ogden (Figure 1-1). The Base is situated just west of the Wasatch Mountain Range. Most of the Base's approximately 6,700 acres are within Davis County with a small portion in Weber County. The Base is situated within the Weber Delta, which consists of broad plains and terraces extending from the shore of the Great Salt Lake eastward to the base of the Wasatch Range. Geologically it is characterized by isolated ranges of buried fault blocks, separated over varying distances by aggraded desert plains (Engineering-Science, 1982).

2.2.2 Topography

Topographically, Hill AFB is on a plateau of the Weber Delta which is approximately 300 feet above the valley floor. The western boundary of the Base is formed by Interstate 15 while the southern portion of the boundary coincides with State Route 193. The northern and eastern perimeters of the Base are marked by the Davis-Weber Canal, a privately owned irrigation canal (Engineering-Science, 1982)(Figure 2-0).

The Weber Delta, located immediately west of the Wasatch Range, slopes in a westerly direction toward the Great Salt Lake. Raised areas, such as the terrace on which Hill AFB is located, are generally level and exhibit slight to moderate relief, especially where dissected by erosional activity. Surface elevations at Hill AFB vary from a low of approximately 4,600 feet MSL along the west installation boundary to 5,045 feet MSL,

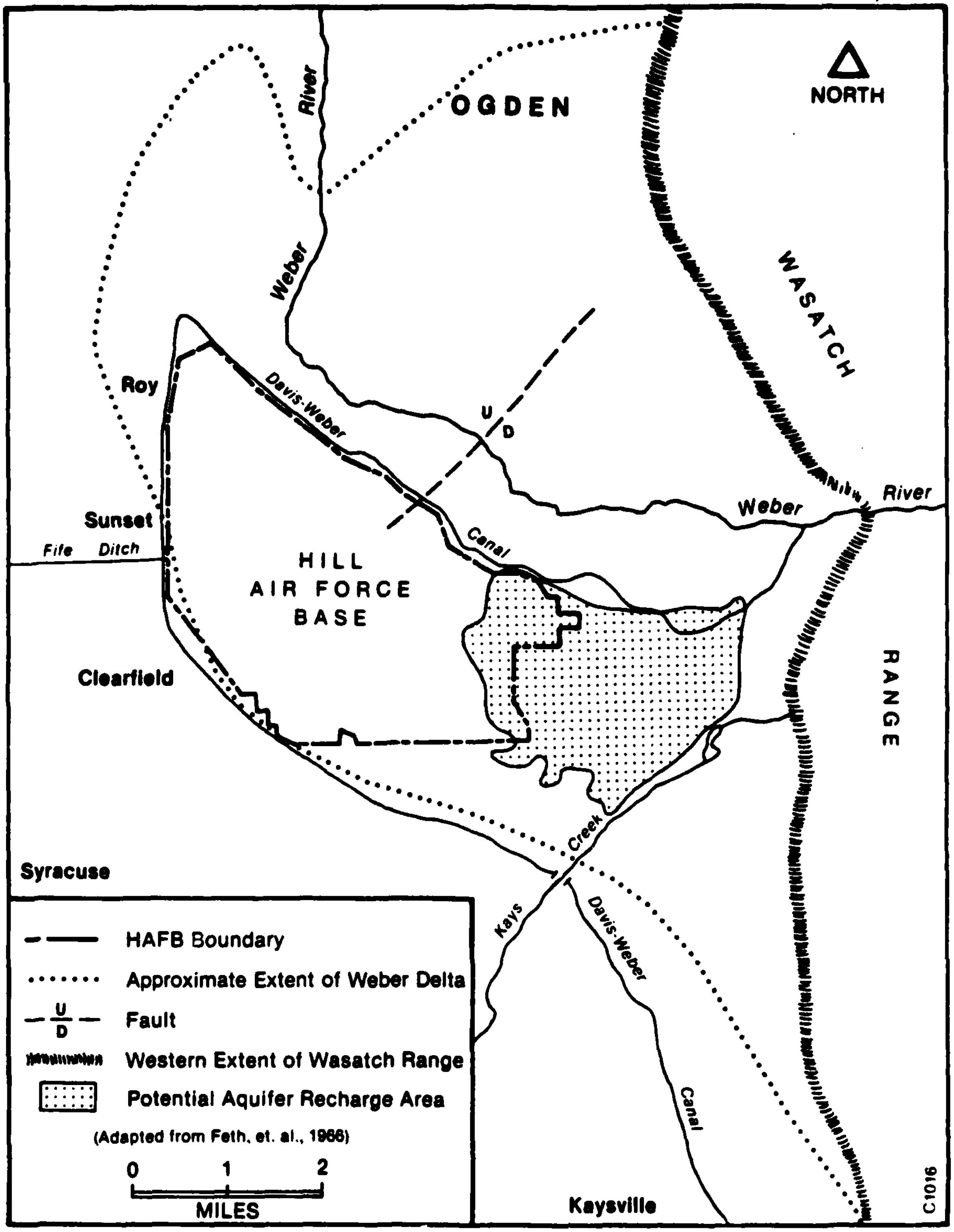

Figure 2-0. Hill AFB Geographical Setting.

towards the installation's eastern boundary. In contrast, the Wasatch Range to the east (Figure 2-0) rises abruptly from the Delta floor to elevations on the order of 9,572 feet MSL at Mount Ogden (Engineering-Science, 1982).

2.1.2 Drainage

The study area drains toward three off-Base drainage systems: Kays Creek, Fife Ditch and the major Base areas toward the Davis-Weber Canal (Figure 2-1). Drainage of installation land areas is accomplished by overland flow to dry swales, terminating at these water courses, or simply by infiltration to surface soils. The water then is either used for irrigation purposes or flows westward into the Great Salt Lake. Flooding is not a common problem in the Hill AFB area, although localized flooding may occur for brief periods where surface drainage is restricted within erosional features. Drainage from the southern portion of the base is routed through drainage ponds to equalize storm flows and eventually terminates in Kays Creek (Engineering-Science, 1982).

2.1.3 Surface Soils

Soil boring information indicates that surface soils at Hill AFB are predominatly silts, clays, sands and gravels typical of the Weber Delta district. Surface soils are well drained and have a slight to moderate erosion susceptability and possess good soil bearing values (Engineering-Science, 1982).

2.1.4 Meteorology

The mean annual precipitation at Hill AFB is 18.9 inches, including a mean annual snowfall of 79 inches (U.S. Air Force Weather Service, 1983). According to the Climatic Atlas of the United States, estimated lake evaporation for the Ogden area averages 40 inches per year.

2.2 Geology and Hydrogeology

2.2.1 Geology

The predominant geologic materials deposited in the Hill Air Force Base area consist of unconsolidated silts, clays, gravels and sands,

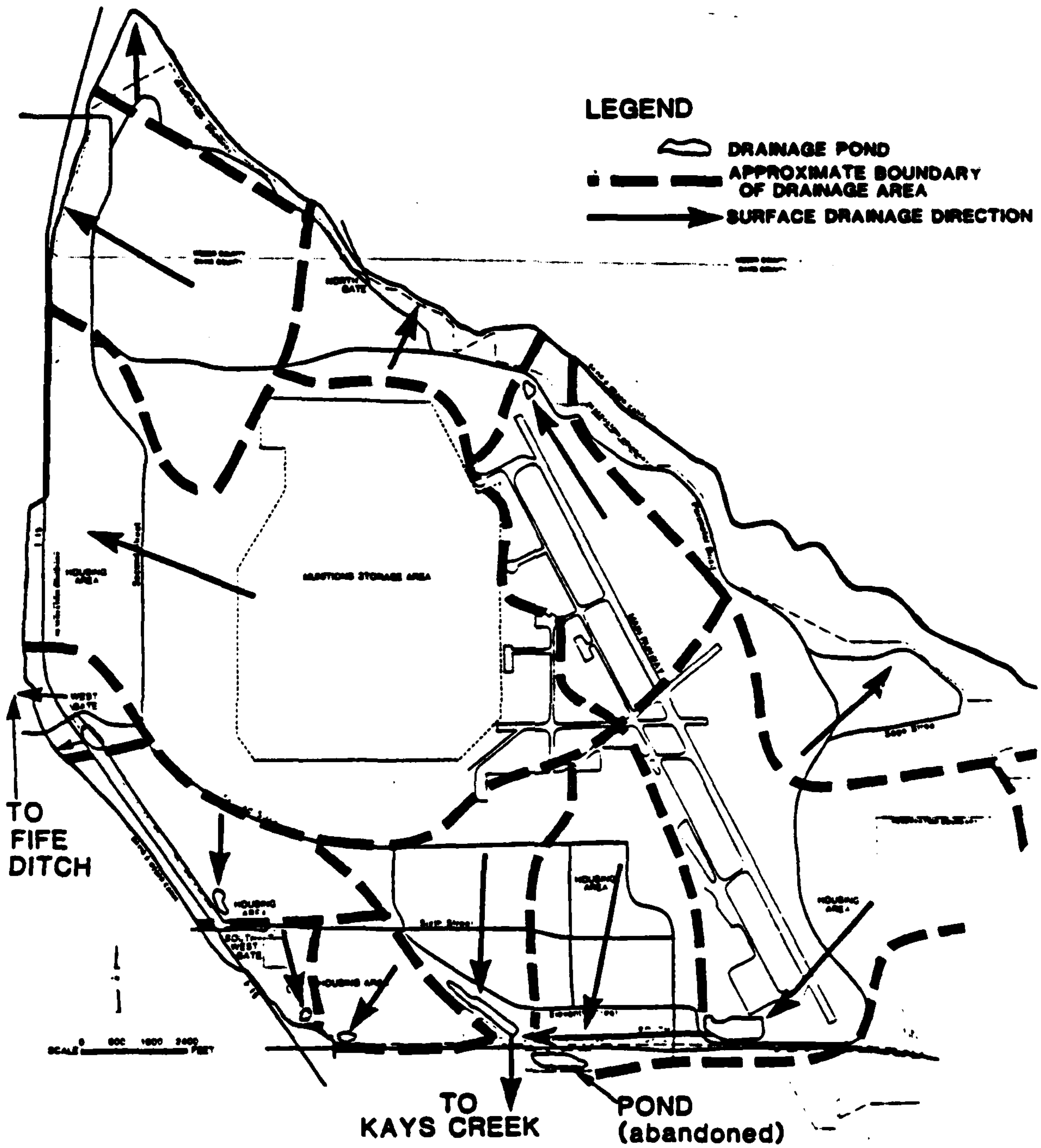

Figure 2-1. Drainage Patterns at Hill AFB.

lineaments interpreted from remote sensing data also exist on the base. Lineaments (a simple linear feature) may indicate the presence of underlying geologic discontinuities, which may have modified the structure of overlying geologic units locally. The Wasatch Fault extends along the western margin of the Wasatch Range, forming the boundary between the Basin and Range Physiographic Province in which the installation is situated and the Rocky Mountains to the east. The Wasatch Fault is probably not a single break, but rather a wide zone of breakage and slippage more than one mile wide and over 150 miles long. Vertical displacement along the fault is thought to exceed 10,000 feet (Feth, et al., 1966)(Engineering-Science, 1982).

Generally, the Wasatch Fault is a normal fault or series of normal faults located essentially at the base of the mountains downthrown to the west and dipping westward an average of 33 degrees. Thrust faults along the basin floor (postulated by Blenn, et al., 1980), may serve as conduits for the horizontal movement of the groundwater. Erosion of the uplifted areas from faulting has created several coarse-grained unconsolidated geological units that conduct to deeper aquifers of the Weber area. This recharge zone extends from about the eastern edge of the base eastward to the Wasatch Mountains (Engineering-Science, 1982)(Figure 2-1).

2.2.3 Hydrogeology

Hill AFB lies within the limits of the Weber Delta groundwater district (Feth, et al., 1966). Groundwater is contained in the unconsolidated alluvial materials that have been deposited in the downfaulted basins of the region. The major sources of recharge to the groundwater reservoir consist of westward subsurface flow from the Wasatch Range, direct infiltration from precipitation and seepage from streams and irrigated areas. Groundwater moves through the system from the recharge areas in a generally westward direction from the Wasatch Range (Engineering-Science, 1982). Recharge areas of concern to this study are shown on Figure 2-1.

Groundwater in the Weber Delta area and at Hill AFB is of the calcium-magnesium-bicarbonate type and occurs in three aquifers -- the Delta Aquifer, Sunset Aquifer and shallow aquifers.

The Delta Aquifer is the principal source of groundwater in the area. This highly permeable artesian aquifer is located from 500 to 700 feet below the surface throughout much of the subdistrict and varies from about 50 to over 150 feet in thickness. Water quality is adequate for most uses although dissolved calcium and magnesium are relatively high. Recharge occurs along the Wasatch Front and from the Weber River (Feth, et al., 1966).

Minor aquifers include the Sunset Aquifer and shallow aquifers underlying the areas of Roy and Syracuse (Figure 2-1), northwest and southwest of Hill AFB, respectively. The artesian Sunset Aquifer generally lies 250 to 400 feet below the surface and varies from 50 to 200 feet thick. Water quality is similar to that of the Delta Aquifer, but permeability is considerably lower (Feth, et al., 1966).

Groundwater in the shallow aquifers is more highly mineralized than in the Delta and Sunset Aquifers. Near Roy (Figure 2-1), the shallow and deep aquifers are not thought to be hydraulically connected. However, in the Syracuse area, pressure relationships suggest that the aquifers may be linked by upward leakage (Feth, et al., 1966).

Perched water tables are known to occur locally in the study area due to the presence of near-surface clay layers at shallow depths. These clay layers impede the downward migration of infiltrating precipitation, which then flows downdip along the clay surface, emerging as springs where the clay intersects the land surface. Most spring activity occurs following periods of precipitation and ceases entirely during dry periods (Engineering-Science, 1982).

2.2.4 Hill AFB Groundwater Supply

Hill AFB currently obtains the majority of its culinary (potable) water supply from Base wells and purchases the remainder from the Weber Basin Water Conservancy District. All Hill AFB wells produce from the Delta Aquifer. Base wells now in service range in depth from 627 feet to 900 feet. Static water levels range from 418 to 515 feet below land surface. The quality of water derived from the Base wells is generally good (Engineering-Science, 1982).

2.3 Hydrogeology of Disposal Areas

Based upon the IRP Phase I Records search the Air Force requested that four waste disposal sites be investigated during the field investigation. The Base Golf Course was also recommended by the Field Team for study. The purpose of adding the Golf Course area was to aid in defining recharge conditions at the study areas downslope from the Golf Course. The following areas were investigated:

- Chemical Disposal Pits Nos. 1 & 2,
- Landfill No. 3,
- Hill AFB Golf Course Area,
- Berman Pond, and
- Chemical Disposal Pit No. 3.

The general locations of these areas are shown on Figure 1-1.

The site specific hydrogeological settings as determined by this IRP Phase II field investigation and by past investigations are discussed in the remainder of this section.

2.3.1 General Hydrogeology of Chemical Disposal Pits Nos. 1 & 2, Landfill No. 3, and Golf Course Areas

Discussion of the hydrogeologic setting of these sites has been combined due to the proximity of the sites and because they overlie the same hydrogeologic system. The sites are shown on Figure 2-2.

Also depicted on Figure 2-2 is Landfill No. 4 which was not part of this investigation but which, because of its size and proximity to the other sites, may affect conditions at these sites. Several previous studies have been conducted to determine groundwater conditions in the vicinity of Landfill No. 4 and to assess the degree of contamination from the disposal activities. The landfill is located immediately southwest of a steep, approximately 200-foot high escarpment above the Weber River Valley on the Base boundary. Leachate seeps have been observed on this escarpment, and analytical data have indicated some high concentrations of

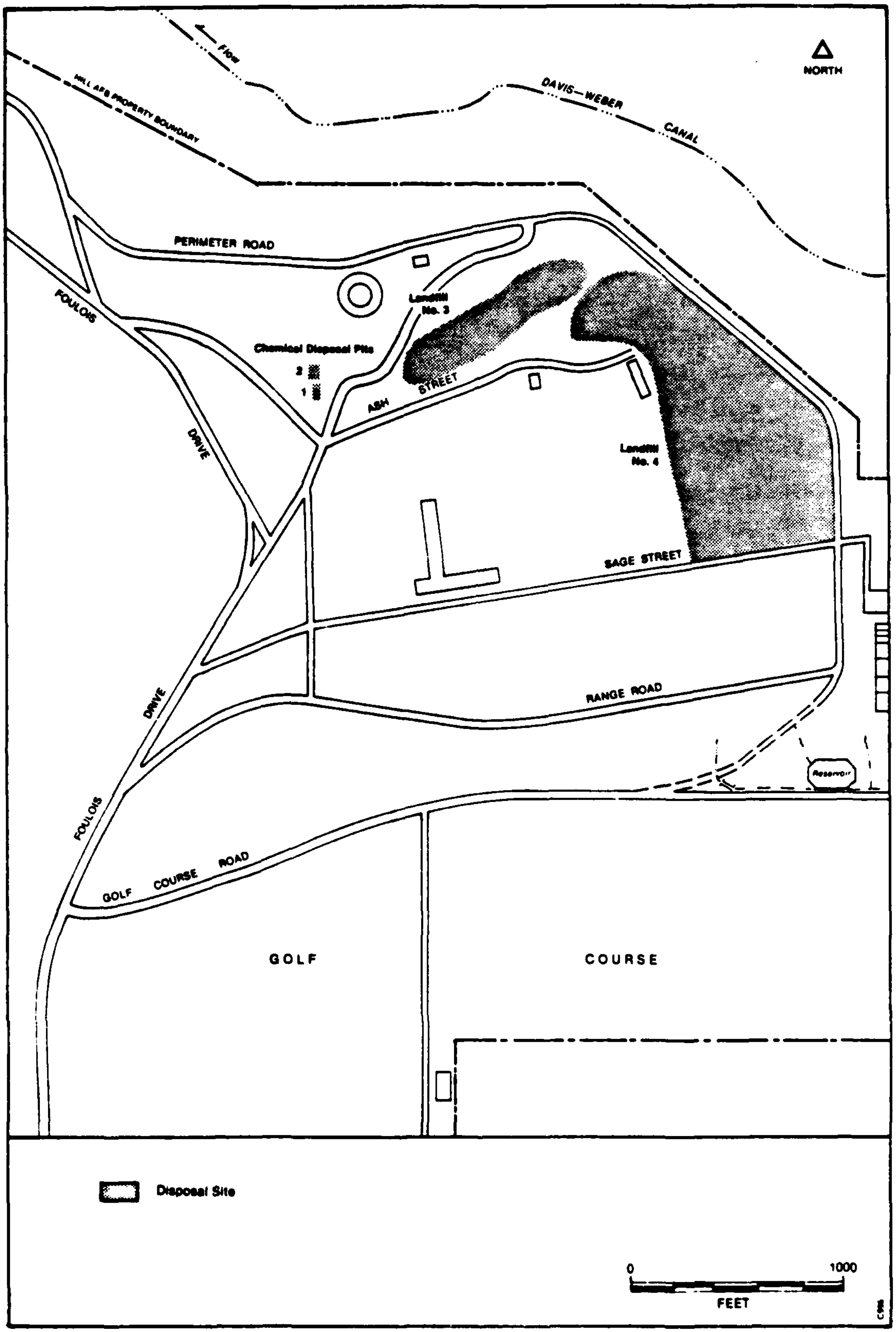

Figure 2-2. Locations of Chemical Disposal Pits Nos. 1 & 2, Landfill No. 3, Golf Course

COD, BOD, iron, and phenols in the leachate (Calscience Research Inc., 1981; OEHL, 1976). Monitoring of the seeps is ongoing. Design activities are currently underway for the installation of an impermeable cap over the landfill (Engineering-Science, 1982).

Previous drilling records indicated that a clay layer exists beneath the site at a depth of about 30-35 feet. A perched water table exists beneath the landfill, surfacing as seeps where the clay is truncated along the escarpment. Prior to this survey, no data were available on the occurrence or quality of groundwater beneath the clay, except in the deeper artesian Delta Aquifer (Engineering-Science, 1982).

There are essentially three hydrogeologic units of concern in this area of Hill AFB. The shallowest is predominantly sand and gravel occurring from ground level to an average of 29 feet in depth. The sand and gravel form a shallow water table aquifer with some areas being locally semi-artesian to artesian. The underlying unit is a clay that appears to be continuous throughout the area and forms the lower boundary of the water table aquifer. The clay thickness at the waste sites is estimated to be about 18 feet; the lower part of the unit grades into clay interbedded with silt and very fine sands and contains groundwater. This zone appears to form a lower aquifer although it is not necessarily hydraulically separated from the shallow aquifer.

Table 2-1 presents a summary of the depth and elevation of clay and groundwater for this area. Tables 2-2 and 2-3 show the data used to derive the information in Table 2-1. The locations of wells and borings are discussed below in Section 2.5.

Figure 2-3 presents a map of the top of clay. Because the clay creates a barrier to downward migration of infiltration, the configuration of the clay surface affects the direction of flow of perched goundwater. Assuming that the top of clay is a completely impermeable barrier, groundwater generally would flow preferentially along the clay "troughs" and around the "highs." The "clay ridge" (approximately 4,780 elevation) just north of Sage Street and the clay "mount" (approximately 4,770 elevation) in the northwest area by Perimeter road are examples of highs in the clay surface which would be expected to control groundwater flow.

Table 2-1. Depth and Elevation Summary of Clay and Ground Water at Chemical Disposal Pit Nos. 1 & 2, Landfill Nos. 3 and 4 and Golf Course Areas

Parameter	Clay	Ground Water
Average Depth (feet)	29.4	18.6
Depth Range (feet)	7-41	1.3-39.7
Average Elevation (feet MSL)	4,771[1]	4,785
Elevation Range (feet MSL)	4,740-4,787	4,763.0-4,815.6
Average Change (2/83 *vs*. 4/83 measurement)	--	+1.9
Average Thickness (feet)	∿18[2]	10.8

[1] Does not include Base Well No. 4 and Monitor Well GC-1 which are outside of the disposal site area and are the extremes in clay elevations encountered during this study of 4,595 ft. and 4,863 ft., respectively.

[2] This value is based upon three deep monitor wells (M-3, M-6, M-10) emplaced during this investigation and 1 previous monitor well (W-14).

Table 2-2. Elevation and Depth of Clay, Landfill Nos. 3, 4, Chemical Disposal Pits 1 & 2 and Golf Course Area

Monitor Well Number[1]	Measuring Point Elevation (Feet MSL)[2]	Measuring Point Height Above Ground Level (Feet)[3]	Depth to Top of Clay Below Ground Level (Feet)	Elevation Top of Clay (Feet MSL)
Base Well No. 4	4,796.37	—	201	4,595
GC-1	4,864.83	1.5	0	4,863
M-1	4,799.53	2.2	32	4,765
M-2	4,798.50	1.1	30	4,767
M-3	4,797.73	1.7	32	4,764
M-4	4,799.19	1.3	25	4,773
M-6	4,804.26	1.5	23	4,780
M-7	4,803.90	1.6	17	4,785
M-9	4,779.32	1.3	7	4,771
M-10	4,779.86	2.5	8	4,769
W-1	4,804.56*	1.4	32	4,771
W-2	4,810.93*	1.5	41	4,774
W-3	4,810.55	2.1	30	4,778
W-4	4,800.25*	2.3	33	4,765
W-7	4,802.69	2.2	21	4,779
W-8	4,802.69	2.4	33	4,767
W-9	4,780.27*	2.0	19	4,759
W-10	4,803.30*	1.8	30	4,772
W-11	4,804.21*	2.0	35	4,767
W-12	4,809.32	1.9	21	4,786
W-13	4,809.84*	0.9	31	4,778
W-14	4,778.21	0.6	29	4,749
80-1-1	4,781.22	0.8	22	4,749
80-2-1	4,792.30	3.3	20	4,769

(Continued)

Table 2-2. (Continued)

Monitor Well Number[1/]	Measuring Point Elevation (Feet MSL)[2/]	Measuring Point Height Above Ground Level (Feet)[3/]	Depth to Top of Clay Below Ground Level (Feet)	Elevation Top of Clay (Feet MSL)
80-3	4,804.23*	1.6	32	4,771
80-4	4,805.95	1.6	31	4,773
80-5	4,807.03*	2.2	28	4,777
80-6	4,811.24	2.5	35	4,774
80-7	4,811.95*	2.5	37	4,772
80-8	4,811.58*	2.5	36	4,773
80-9	4,808.97	1.6	31	4,776
80-10	4,812.13	1.3	31	4,780
80-11	4,811.88	1.7	30	4,780
80-12	4,812.00	2.7	34	4,775
80-13	4,809.30*	2.3	25	4,782
80-14	4,807.42*	2.0	31	4,774
80-15	4,804.60*	2.6	33	4,769[4/]
80-16	4,806.42	3.2	35	4,768[4/]
80-17	4,810.57	1.5	30	4,779
80-18	4,817.60*	2.0	30	4,786
80-19	4,808.57*	1.9	31	4,776
80-20	4,799.43*	1.6	30	4,768
80-21	4,777.79*	1.6	24	4,752
80-22	4,803.05	2.2	31	4,770
80-23	4,803.49	3.3	36	4,764
80-24	4,810.85*	2.6	33	4,775
80-25	4,804.60	2.8	37	4,765
W-5	—	—	33	±4,767 est
W-6	—	—	33	±4,771 est

Table 2-2. (Continued)

NOTE:

1/Monitor Wells

a. GC-1 and "M" series wells emplaced by Radian Corporation November/December 1982; Driller - Construction Drilling International, Salt Lake City.

b. "W" series wells emplaced by U.S. Air Force about 1976; Driller - unknown; W-5 and W-6 not located in the field.

c. "X" series wells emplaced by U.S. Air Force (?) pre 1976; Driller - unknown.

d. "80" series wells emplaced by U.S. Air Force 1980; Driller - Peterson Brothers Drilling Company, Salt Lake City.

2/Measuring point elevations surveyed by Hill AFB Civil Engineers (July 1980, March 1981, May 1983). Pre-1983 survey measurements denoted by an "*".

3/Height of measuring point above ground level measured by Radian Corporation, February 1983.

4/Elevation of top of clay appears anomalous relative to other nearby well data.

Table 2-3. Selected Ground-Water Level Information in the Vicinity of Chemical Disposal Pits 1 & 2, Landfills Nos. 3 & 4 and Golf Course Areas

Monitor Well Number[1]	Depth to Water (Feet Below Measuring Point)[2]	Static Water Level Change (Feet)	Measuring Point Elevation (Feet MSL)[3]	Static Water Level Elevation (Feet MSL)	Measuring Point Height Above Ground Level (Feet)[3]	Ground Level Elevation (Feet MSL)	Depth to Water Below Ground Level (Feet)
GC-1	41.18 (2-25-83)		4,864.83	4,823.7	1.5	4,863.3	39.7
	37.35 (4-28-83)	+3.8	4,864.83	4,827.5	1.5	4,863.3	35.9
M-1	24.72 (2-24-83)		4,799.53	4,774.8	2.2	4,797.3	22.5
	21.39 (4-26-83)	+3.3	4,799.53	4,778.1	2.2	4,797.3	19.2
M-2	27.80 (2-24-83)		4,798.50	4,770.7	1.1	4,797.4	26.7
	24.62 (4-26-83)	+3.2	4,798.50	4,773.9	1.1	4,797.4	23.5
M-3	34.70 (2-24-83)		4,797.73	4,763.0	1.7	4,796.0	33.0
	33.27 (4-26-83)	+1.4	4,797.73	4,764.5	1.7	4,796.0	31.6
M-4	25.06 (2-24-83)		4,799.19	4,774.1	1.3	4,797.9	23.8
	24.08 (4-26-83)	+1.0	4,799.19	4,775.1	1.3	4,797.9	22.8
M-6	19.11 (2-24-83)		4,804.26	4,785.2	1.5	4,802.8	17.6
	16.72 (4-27-83)	+2.4	4,804.26	4,787.5	1.5	4,802.8	15.2
M-7	18.36 (2-24-83)		4,803.90	4,785.5	1.6	4,802.3	16.8
	16.14 (4-27-83)	+2.2	4,803.90	4,787.8	1.6	4,802.3	14.5
M-9	2.74 (2-23-83)		4,779.32	4,776.6	1.3	4,778.0	1.4
	2.63 (4-26-83)	+0.1	4,779.32	4,776.7	1.3	4,778.0	1.3
M-10	14.70 (2-23-83)		4,779.86	4,765.2	2.5	4,777.4	12.2
	13.53 (4-26-83)	+1.2	4,779.86	4,766.3	2.5	4,777.4	11.0
W-1	21.64 (2-23-83)		4,804.56*	4,782.9	1.4	4,803.2	20.2
	19.48 (4-26-83)	+2.2	4,804.56*	4,785.1	1.4	4,803.2	18.1
W-2	17.25 (2-23-83)		4,810.93	4,793.7	1.5	4,809.4	15.8
	16.15 (4-26-83)	+1.1	4,810.93	4,794.8	1.5	4,809.4	14.7

(Continued)

Table 2-3. (Continued)

Monitor Well Number[1]	Depth to Water (Feet Below Measuring Point)[2]	Static Water Level Change (Feet)	Measuring Point Elevation (Feet MSL)[3]	Static Water Level Elevation (Feet MSL)	Measuring Point Height Above Ground Level (Feet)[3]	Ground Level Elevation (Feet MSL)	Depth to Water Below Ground Level (Feet)
W-3	20.48 (2-23-83)		4,810.55	4,790.1	2.1	4,808.5	18.4
	18.35 (4-26-83)	+2.1	4,810.55	4,792.2	2.1	4,808.5	16.3
W-4	24.65 (2-25-83)		4,800.25*	4,775.6	2.3	4,798.0	22.4 (oil)*
	21.59 (4-26-83)	+3.1	4,800.25*	4,778.7	2.3	4,798.0	19.3 (oil)*
W-7	21.03 (2-24-83)		4,802.69	4,781.7	2.2	4,800.5	18.8
	18.63 (4-27-83)	+2.4	4,802.69	4,784.1	2.2	4,800.5	16.4
W-8	22.41 (2-24-83)		4,802.69	4,780.3	2.4	4,800.3	20.0
	19.54 (4-27-83)	+2.9	4,802.69	4,783.2	2.4	4,800.3	17.1
W-9	1.80 (2-24-83)		4,780.27*	4,778.5	2.0	4,778.3	+0.2 □
	1.55 (4-26-83)	+0.3	4,780.27*	4,778.7	2.0	4,778.3	+0.5 □
W-10	22.43 (2-24-83)		4,803.30*	4,780.9	1.8	4,801.5	20.6
	20.20 (4-28-83)	+2.2	4,803.30*	4,783.1	1.8	4,801.5	18.4
W-11	18.37 (2-23-83)		4,804.21*	4,785.8	2.0	4,802.2	16.4
	15.70 (4-26-83)	+2.7	4,804.21*	4,788.5	2.0	4,802.2	13.7
W-12	21.38 (2-24-83)		4,809.32	4,787.9	1.9	4.807.4	19.5
	19.41 (4-27-83)	+2.0	4,809.32	4,789.9	1.9	4.807.4	17.5
W-13	15.28 (2-23-93)		4,809.84*	4,794.6	0.9	4,808.9	14.4
	14.09 (4-26-83)	+1.2	4,809.84*	4,795.8	0.9	4,808.9	13.2
W-14	1.5 ice (2-23(?)-83)		4,778.21	4,776.7 (ice)	2.0	4,777.6	0.9 □
	— ice (4-26(?)-83)	—	4,778.21	— (ice)	2.0	4,777.6	—
X-1	19.33 (2-23-83)		4,809.34	4,790.0	0.9	4,808.4	18.4
	17.22 (4-26-83)	+2.1	4,809.34	4,792.1	0.9	4,808.4	16.3
X-2	19.35 (2-23-83)		4,811.18	4,791.8	1.0	4,810.2	18.4
	17.97 (4-26-83)	+1.4	4,811.18	4,793.2	1.0	4,810.2	17.0

(Continued)

<u>Remarks</u>

* Depth to top of oil slick
□ Standing water outside and inside casing.

Table 2-3. (Continued)

Monitor Well Number[1]	Depth to Water (Feet Below Measuring Point)[2]	Static Water Level Change (Feet)	Measuring Point Elevation (Feet MSL)[3]	Static Water Level Elevation (Feet MSL)	Measuring Point Height Above Ground Level (Feet)[4]	Ground Level Elevation (Feet MSL)	Depth to Water Below Ground Level (Feet)
X-3	16.41 (2-23-83)		4,809.97	4,793.6	1.2	4,808.8	15.2
	16.41 (4-26-83)	0	4,809.97	4,793.6 (plugged?)	1.2	4,808.8	15.2 †
80-1	6.19 (2-23-83)		4,781.22	4,775.0	0.8	4,780.4	5.4
	4.43 (4-26-83)	+1.8	4,781.22	4,776.8	0.8	4,780.4	3.6
80-2	17.35 (2-23-83)		4,792.30	4,775.0	3.3	4,789.0	14.1
	16.87 (4-26-83)	+0.5	4,792.30	4,775.4	3.3	4,789.0	13.6
80-3	24.78 (2-23-83)		4,804.23	4,779.5	1.6	4,802.6	23.2
	23.02 (4-26-83)	+1.8	4,804.23	4,781.2	1.6	4,802.6	21.4
80-4	25.28 (2-23-83)		4,805.95	4,780.7	1.6	4,804.4	23.7
	23.14 (4-26-83)	+2.1	4,805.95	4,782.8	1.6	4,804.6	21.5
80-5	25.23 (2-23-83)		4,807.03*	4,781.8	2.2	4,804.8	23.0
	23.05 (4-26-83)	+2.2	4,807.03*	4,784.0	2.2	4,804.8	20.9
80-6	26.78 (2-23-83)		4,811.24	4,784.5	2.5	4,808.7	24.3
	23.67 (4-26-83)	+3.1	4,811.24	4,787.6	2.5	4,808.7	21.2
80-7	23.54 (2-23-83)		4,811.95*	4,788.4	2.5	4,809.5	21.0
	22.47 (4-27-83)	+1.1	4,811.95*	4,789.5	2.5	4,809.5	20.0
80-8	25.47 (2-23-83)		4,811.58*	4,786.1	2.5	4,809.1	23.0
	24.25 (4-27-83)	+1.2	4,811.58*	4,787.3	2.5	4,809.1	21.8
80-9	24.92 (2-23-83)		4,808.97	4,784.1	1.6	4,807.4	23.3
	22.39 (4-27-83)	+2.5	4,808.97	4,786.6	1.6	4,807.4	20.8
80-10	17.73 (2-23-83)		4,812.13	4,794.4	1.3	4,810.8	16.4
	16.61 (4-27-83)	+1.1	4,812.13	4,795.5	1.3	4,810.8	15.3

(Continued)

Remarks

† Well plugged (?)

Table 2-3. (Continued)

Monitor Well Number[1]	Depth to Water (Feet Below Measuring Point)[2]	Static Water Level Change (Feet)	Measuring Point Elevation (Feet MSL)[3]	Static Water Level Elevation (Feet MSL)	Measuring Point Height Above Ground Level (Feet)[3]	Ground Level Elevation (Feet MSL)	Depth to Water Below Ground Level (Feet)
80-11	20.87 (2-23-83)		4,811.88	4,791.0	1.7	4,810.2	19.2
	19.00 (4-27(?)-83)	+1.9	4,811.88	4,792.9	1.7	4,810.2	17.3
80-12	22.38 (2-23-83)		4,812.00	4,789.6	2.7	4,809.3	19.7
	20.53 (4-27-83)	+1.9	4,812.00	4,791.5	2.7	4,809.3	17.8
80-13	21.37 (2-23-83)		4,809.30*	4,787.9	2.3	4,807.0	19.1
	19.15 (4-27-83)	+2.2	4,809.30*	4,790.2	2.3	4,807.0	16.9
80-14	20.59 (2-24-83)		4,807.42*	4,786.8	2.0	4,805.4	18.6
	18.62 (4-27-83)	+2.0	4,807.42*	4,788.8	2.0	4,805.4	16.6
80-15	19.11 (2-24-83)		4,804.60*	4,785.5	2.6	4,802.0	16.5
	16.76 (4-27-83)	+2.4	4,804.60*	4,787.8	2.6	4,802.0	14.2
80-16	18.88 (2-24-83)		4,806.42	4,787.5	3.2	4,803.2	15.7
	16.49 (4-27-83)	+2.4	4,806.42	4,789.9	3.2	4,803.2	13.3
80-17	17.80 (2-23-83)		4,810.57	4,792.8	1.5	4,809.1	16.3
	16.47 (4-26-83)	+1.3	4,810.57	4,794.1	1.5	4,809.1	15.0
80-18	16.80 (2-23-(?)-83)	-	4,817.60*	4,800.8	2.0	4,815.6	14.8 Δ
	16.80 (4-26-(?)-83)		4,817.60*	4,800.8	2.0	4,815.6	14.8 Δ
80-19	15.71 (2-23-83)		4,808.57*	4,792.9	1.9	4,806.7	13.8
	15.07 (4-26-83)	+0.6	4,808.57*	4,793.5	1.9	4,806.7	13.2
80-20	21.66 (2-24-(?)-83)		4,799.43*	4,777.8	1.6	4,797.8	20.1 (oil)*
	18.65 (4-26-83)	+3.0	4,799.43*	4,780.8	1.6	4,797.8	17.1 (oil)*
80-21	1.5 (2-24-83)		4,777.9*	4,776.3	1.6	4,776.2	+0.1 ♠
	1.7 (4-26-83)	+0.2	4,777.9*	4,776.1	1.6	4,776.2	0.1 ●

(Continued)

Remarks

Δ Total depth and dry
* Depth to top of oil slick
♠ Water inside and outside frozen-same level
● Water inside frozen, outside was fluid-same level

Table 2-3. (Continued)

Monitor Well Number[1]	Depth to Water (Feet Below Measuring Point)[2]	Static Water Level Change (Feet)	Measuring Point Elevation (Feet MSL)[3]	Static Water Level Elevation (Feet MSL)	Measuring Point Height Above Ground Level (Feet)[4]	Ground Level Elevation (Feet MSL)	Depth to Water Below Ground Level (Feet)
80-22	23.82 (2-24-83)		4,803.05	4,779.2	2.2	4,800.9	21.6
	22.22 (4-27-83)	+1.6	4,803.05	4,780.8	2.2	4,800.9	20.0
80-23	26.20 (2-23-83)		4,803.49	4,777.3	3.3	4,800.2	22.9
	24.83 (4-26-83)	+1.4	4,803.49	4,778.7	3.3	4,800.2	21.5
80-24	28.62 (2-23-83)		4,810.85	4,782.2	2.6	4,808.3	26.0
	25.70 (4-27-83)	+2.9	4,810.85	4,785.2	2.6	4,808.4	23.1
80-25	23.03 (2-23-83)		4,804.60	4,781.6	2.8	4,801.8	20.2
	20.33 (4-27-83)	+2.7	4,804.60	4,784.3	2.8	4,801.8	17.5

[1] Monitor Wells
- a. GC-1 and "M" series wells emplaced by Radian Corporation November/December 1982; Driller - Construction Drilling International, Salt Lake City, Utah.
- b. "W" series wells emplaced by U.S. Air Force about 1976; Driller - unknown.
- c. "X" series wells emplaced by U.S. Air Force (?) pre 1976; Driller - unknown.
- d. "80" series wells emplaced by U.S. Air Force 1980; Driller - Peterson Brothers Drilling Company, Salt Lake City, Utah.

[2] Selected static water level measurements obtained during Radian Corporation Hill IRP Phase II Field Investigation.

[3] Measuring point elevations surveyed by Hill AFB Civil Engineers (July 1980, May 1983). Asterisk (*) denotes pre-1983 elevation survey measurements.

[4] Height of measuring point above ground level measured by Radian Corporation, February 1983.

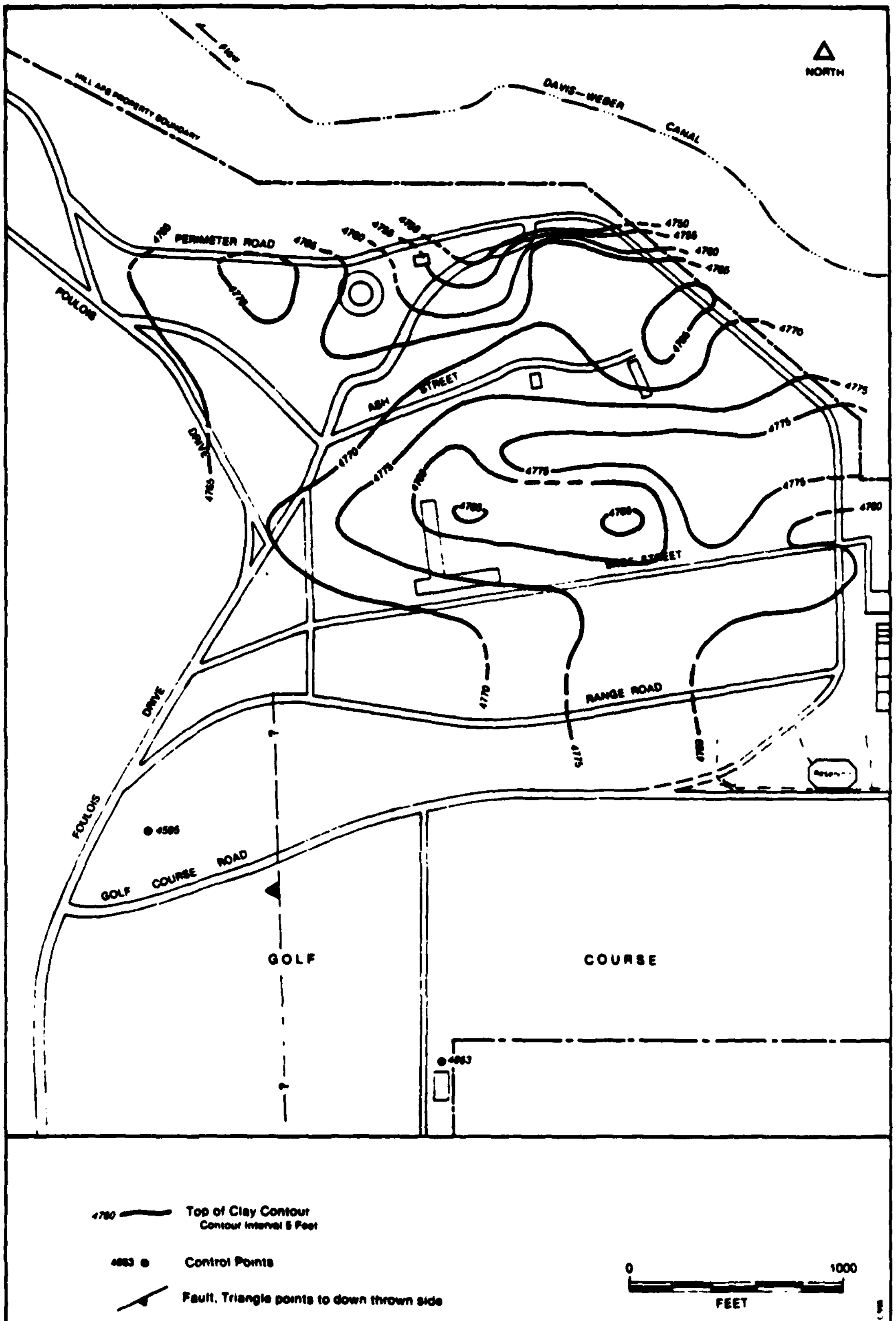

Figure 2-3. Elevation of the Top of Clay in the Vicinity of Chemical Disposal Pits Nos. 1 and 2, and Landfill No. 3.

Evidence from geophysics (Glenn, 1980), well logs and geomorphology suggests that a normal fault exists on the western side of the Golf Course. It is not known if the fault has affected the clay layer or the flow of groundwater beneath the waste sites.

Groundwater level measurements for the upper and lower aquifer were taken in February and April 1983. Equipotential contours (contours of groundwater levels) for April 1983 are shown on Figure 2-4. Because this was an unusually wet period for the area, the April groundwater levels reflect extreme conditions and provide a good indication of the potential for groundwater flow into wastes in the disposal areas. Also depicted on Figure 2-4 are the groundwater levels in the lower aquifer measured in monitor wells M-3, M-6, M-10. These three monitor wells were completed in the lower aquifer. Monitor Well M-6 has a static water elevation similar to that of the upper aquifer. This is not unusual as Monitor Well M-6 is located near the common recharge area (i.e. south of Sage Street) for both the upper and lower aquifer. Therefore, similar static water levels are to be expected. The water-level elevation in Golf Course well GC-1 is also shown. Seeps and springs are depicted as well on Figure 2-4. These groundwater discharges are located downslope from the waste sites on the Weber River Valley escarpment.

The groundwater flow in the shallow and lower aquifers is predominantly northward towards the Weber River Valley. (Groundwater flow is perpendicular to the equipotential lines or contour lines shown on Figure 2-4.) There are two distinct components of flow. The first component trends to the northwest in the vicinity of Monitor Well M-3 (Figure 2-4). The second flow component is to the north in the east side of the area, north of Sage Street. These flows trend toward Chemical Disposal Pits 1 & 2 and Landfill No. 4, respectively (Figure 2-2). The 4795-foot contour suggests the possibility of groundwater recharge from the Golf Course area.

Figure 2-5 provides an overview of the groundwater level change that occurred between the February 1983 and April 1983 measurements. All of the groundwater levels rose in elevation due to the winter recharge and precipitation, with the greatest area of change being on the west and

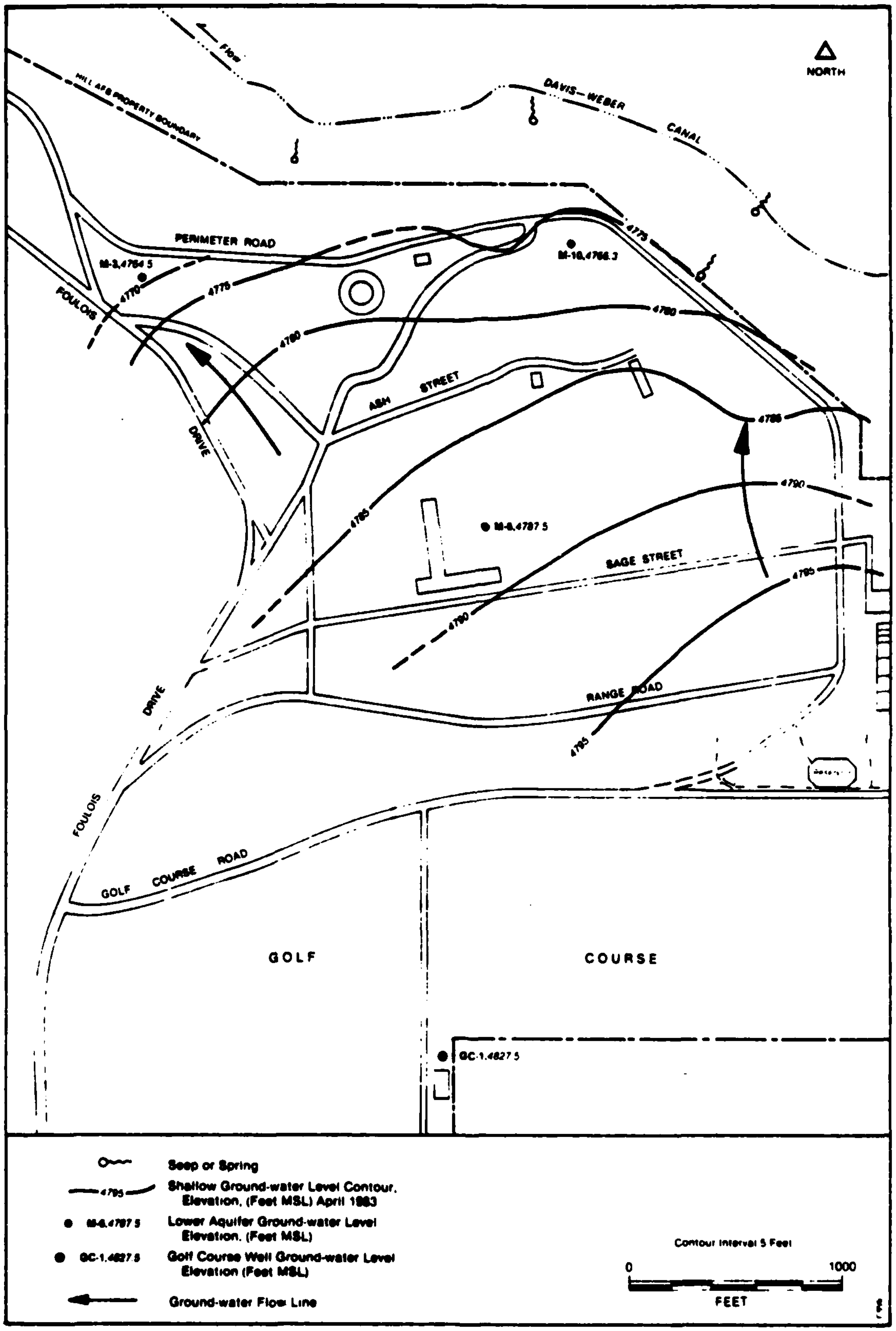

Figure 2-4. Ground-Water Levels (April, 1983) in the Vicinity of Chemical Disposal Pits Nos. 1 and 2, Landfill No. 3 and Golf Course.

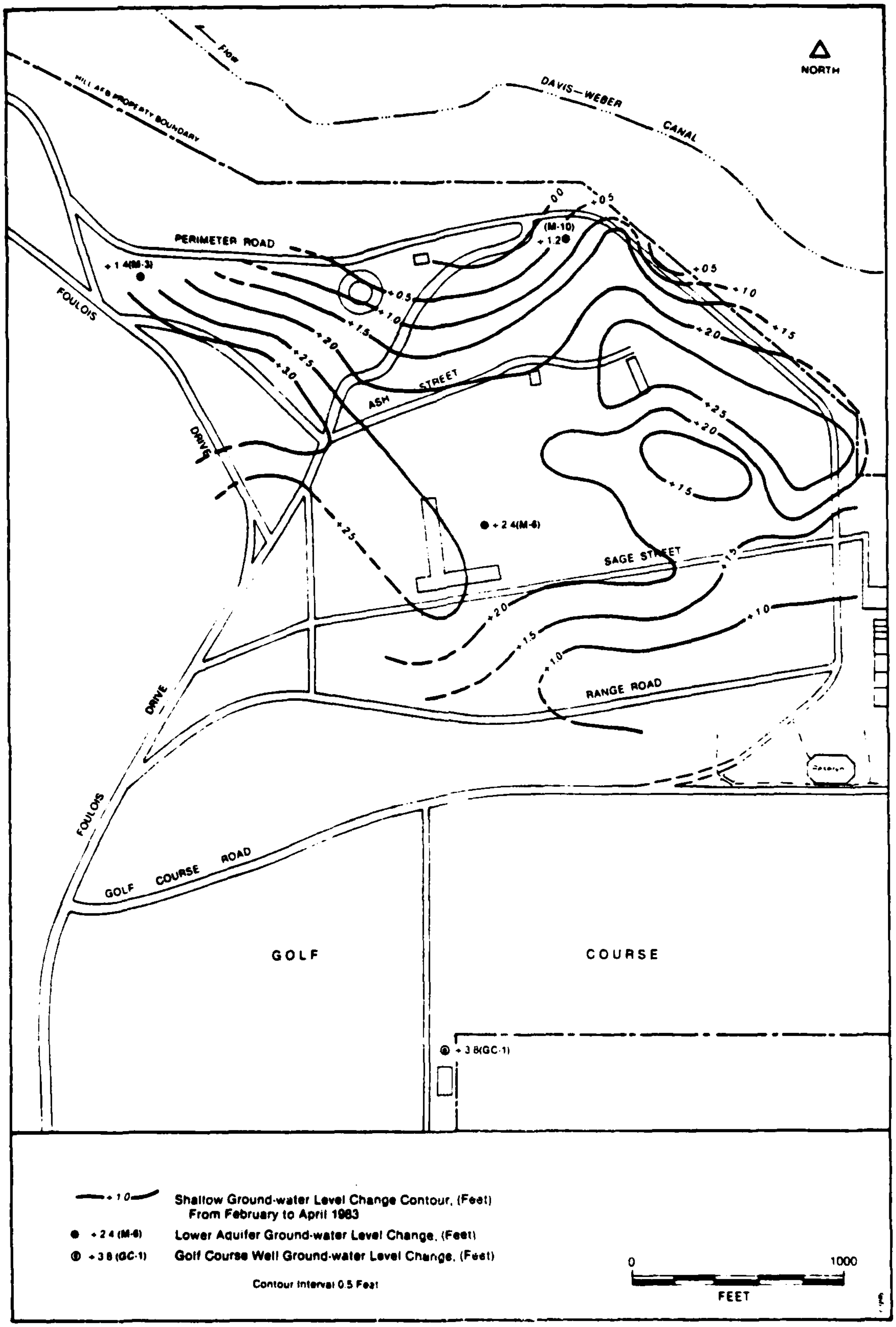

Figure 2-5. Change to Ground-Water Levels in the Vicinity of Chemical Disposal Pits Nos. 1 and 2, Landfill No. 3 and Golf Course, February to April, 1983.

northwest sides. The areas of greatest change thus correspond with the northwest and northeast trending zones of groundwater flow suggested by the groundwater contours (Figure 2-4). The lower aquifer monitor wells also show a positive response, but smaller than the change in the upper aquifer. At the Golf Course, the static water level change was +3.8 feet, which was the greatest change observed overall.

Two hydrogeologic profiles were constructed to provide an insight into the groundwater flow regime. The locations of the two profiles are depicted on Figure 2-6; the supporting geologic logs are provided in Appendix C. For the purpose of clarity, some of the logs were simplified for the profiles. North-south profile A-A' on Figure 2-7 shows the groundwater levels in the shallow and lower aquifers in relationship to each other and to the top-of-clay. The static water levels in the shallow and lower aquifers tend to diverge in the vicinity of Monitor Well M-10 on the north side, while in the mid-section of the profile the two groundwater levels appear to converge. This suggests that both aquifers have common recharge areas. This is evidenced at Monitor Wells M-6, completed in the lower artesian aquifer, and adjacent Monitor Well M-7, completed in the upper water table aquifer. Monitor Well M-6 with an artesian water level elevation of 4787.5 feet MSL (April 1983) is 7 1/2 feet above the top of the clay at elevation 4780 feet. This static water level is similar in elevation to that of the water table Monitor Well M-7 of elevation 4787.8 feet (April 1983). The lower aquifer appears to be hydraulically connected throughout the area under the clay. The main area of recharge to the lower aquifer is south of the area of Monitor Well M-7, which may include the Golf Course area.

An east-west profile is shown on Figure 2-8. The northwest and north-east trending flow directions previously addressed are apparent on this profile. Note the clay "high" in the vicinity of Monitor Well W-7, and by Well 80-14 the relative drop in static water level elevation to either side. Monitor Well M-3 is screened across the lower aquifer. Also depicted are the relative locations of the various disposal sites on or near this profile. Well 80-9 shows the possibility of groundwater incursion into a portion of Landfill No. 4.

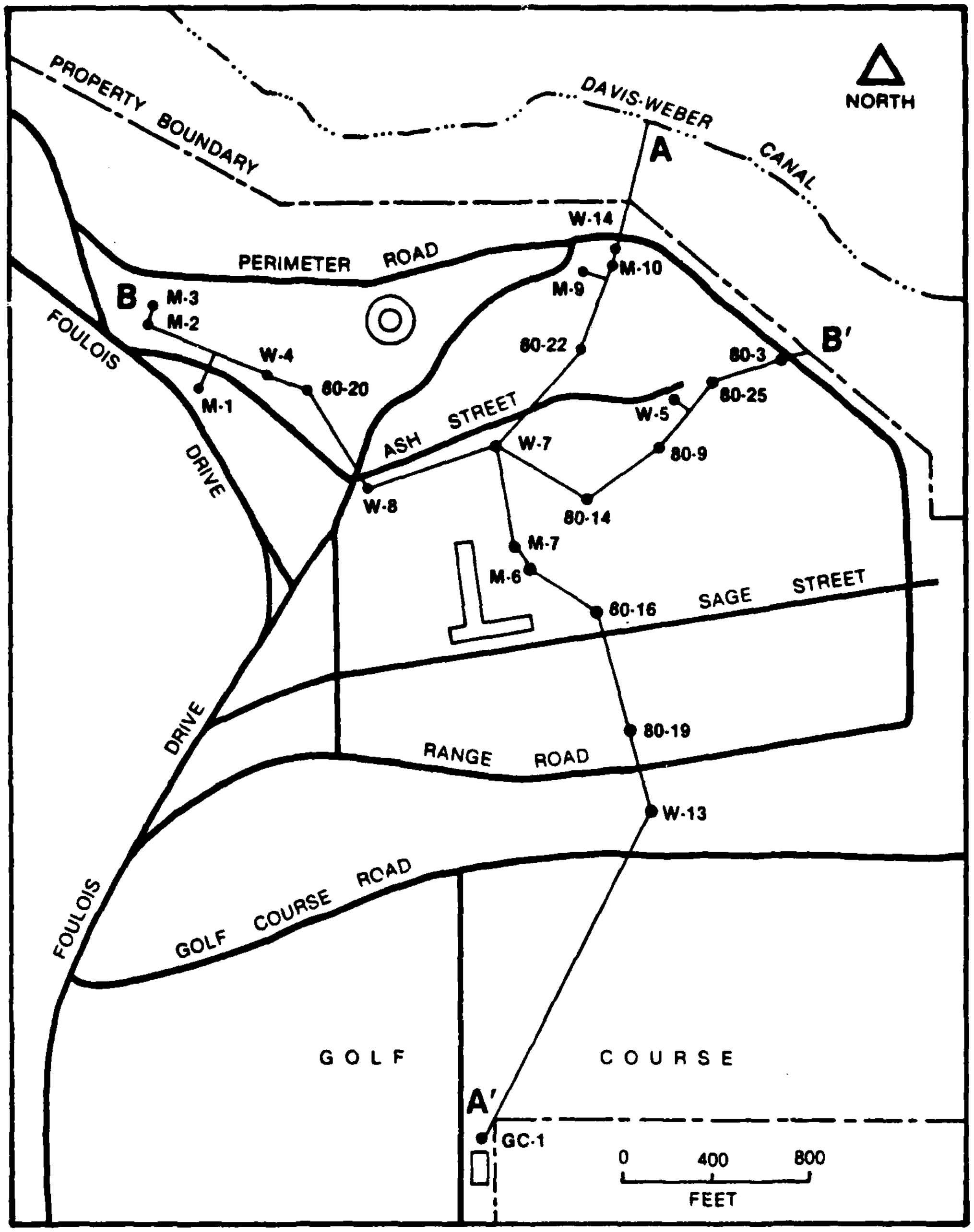

Figure 2-6. Locations of Hydrogeologic Cross Sections in the Vicinity of Chemical Disposal Pit Nos. 1 and 2, Landfill Nos. 3 and 4, and Golf Course

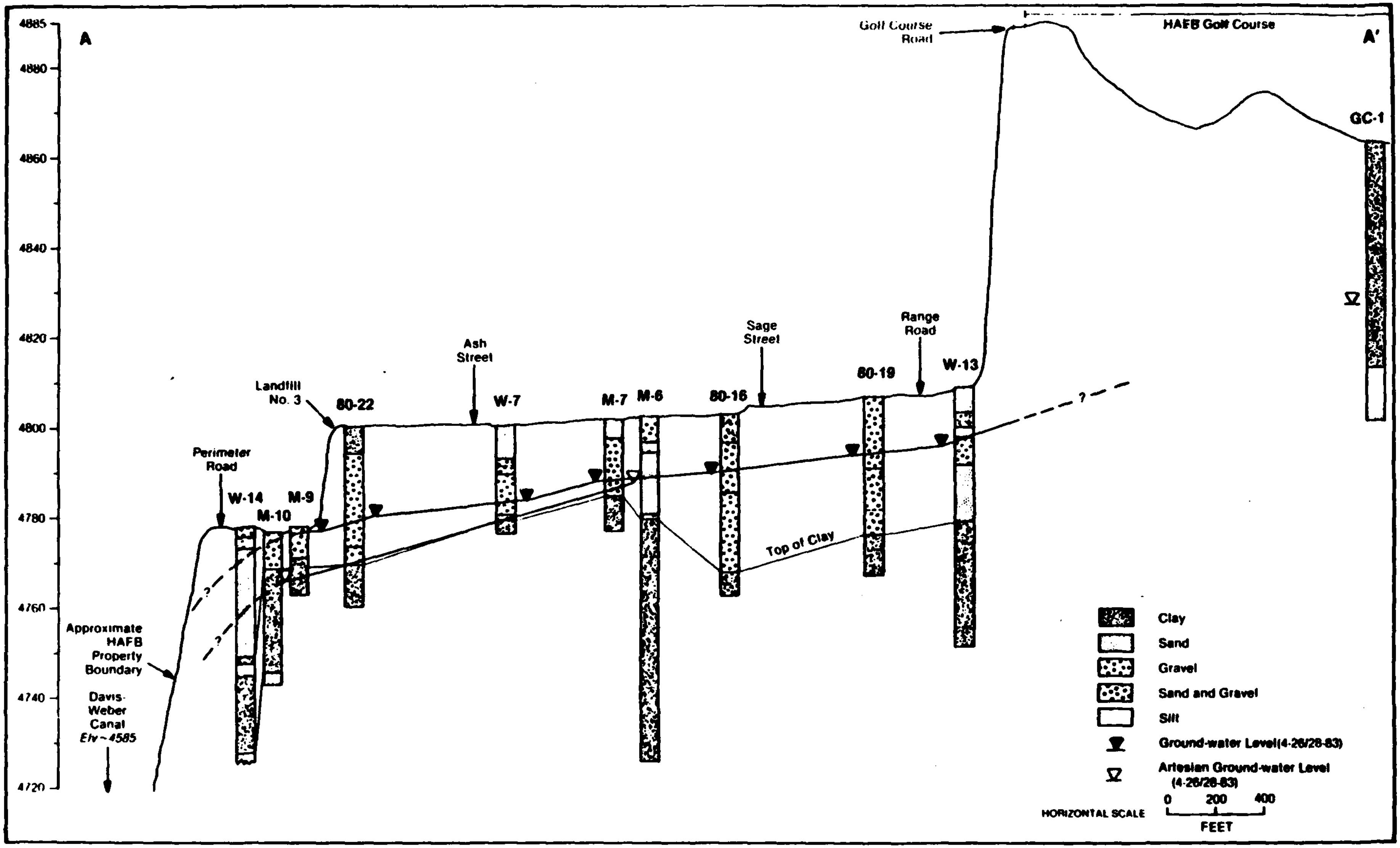

Figure 2-7. Hydrogeologic Profile A-A' in the Vicinity of Landfill No. 3 and Golf Course

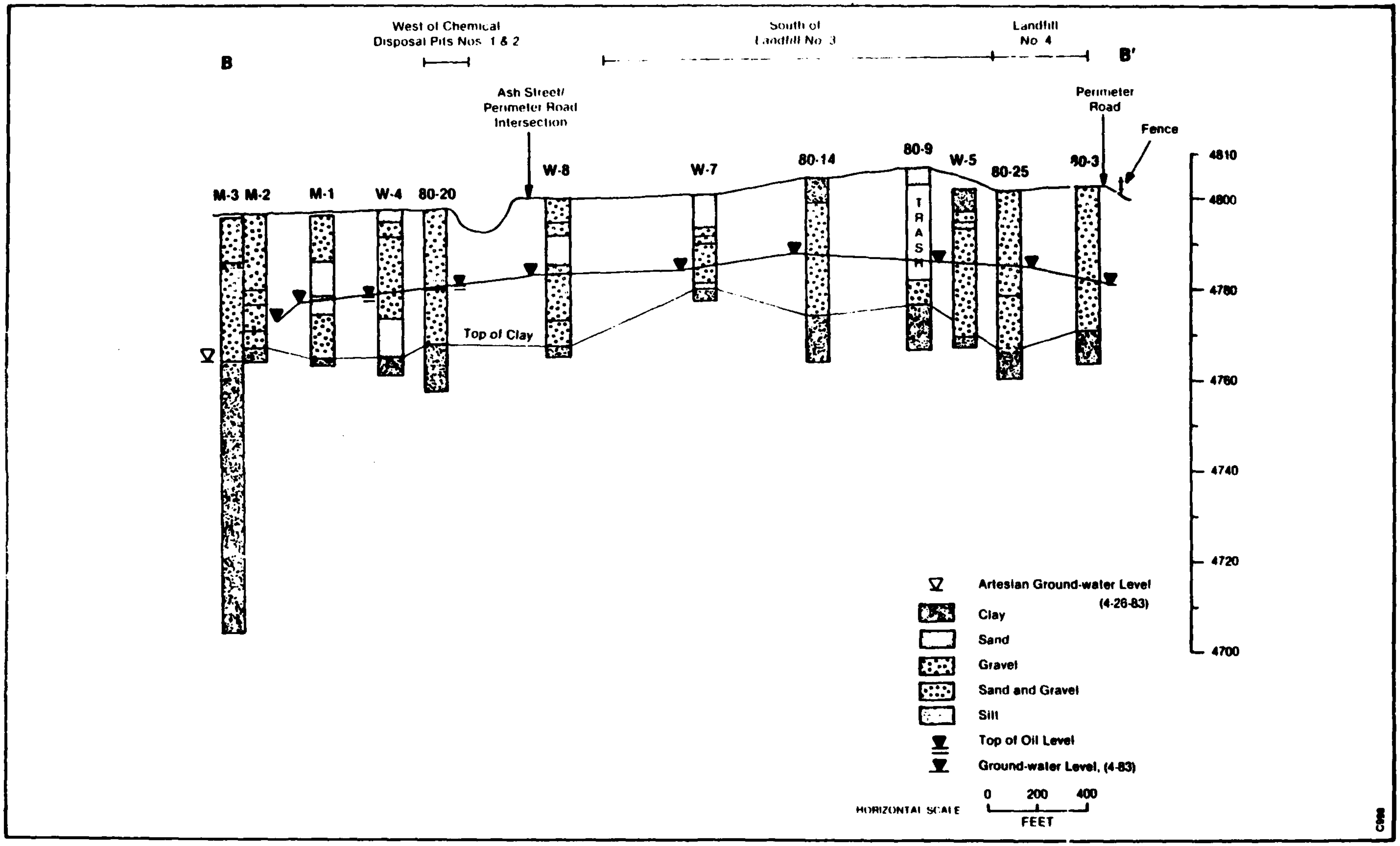

Figure 2-8. Hydrogeologic Profile B-B' in the Vicinity of Chemical Disposal Pits Nos. 1 and 2, Landfill Nos. 3 and 4.

In-situ measurements of temperature and conductivity of groundwater were taken throughout the study area. These were used as a reconnaisance tool in an attempt to qualitatively determine relative groundwater flow direction(s), recharge area(s) and chemical impacts due to the waste sites. Table 2-4 presents a summary of the measurements taken during the February 1983 and April 1983 field activities. These summary data reflect information collected from monitor wells nearest the sites studied. Table 2-5 presents the supporting field data collected for the 49 monitor wells in these areas. In general, the available data are not sufficient to permit the determination of specific trends. One exception is a slight downward change in average conductivity values from February 1983 to April 1983 shown on Table 2-4. This appears to be the result of the recharge and the consequent dilution of groundwaters.

There are a number of factors that affect the temperature and conductivity measured in the field. Some of these factors are well completion materials, screen position in the aquifer, surface waters/drainage, hydrogeology, season and waste site proximity. The factor which appears to have had the greatest effect on these data is seasonal, in that the measurements were taken in winter (February and April), and thus do not display a significant change. On the other hand, measurements taken in the summer would reflect warmer temperatures and slower groundwater flows and leachate generation. These conditions can result in elevated conductivity values. The contrast between winter and summer measurements would aid in defining the hydrogeological system and subsequent contamination flow.

2.3.2 General Hydrogeology of Berman Pond

Berman Pond is located near the south gate of Hill AFB (Figure 2-9) where the hydrogeologic materials underlying the pond appear to be typical of the Weber Delta system. Being further from the Wasatch Range than the other waste disposal sites, Berman Pond is underlain in the near-surface by unconsolidated sands and silts that are fine-grained and permeable. With depth, the sands become interbedded with clay. Based on the limited data obtained from the geophysical survey from the two and monitor wells emplaced at Berman Pond, the clays appear to be non-uniform in thickness and discontinuous under the site.

Table 2-4. Summary of In-Situ Temperature and Conductivity Data of Ground-Water

Study Area	Ground Water Temperature-°C			Ground Water Conductivity-μmhos/cm		
	Average[1]	Range[1]	Average Change[2]	Average at 25°C[1]	Range[1]	Average Change[2]
Chemical Disposal Pits No. 1 & 2	11.9	13.0-11.0	-0.8	870	560-1,270	-317
Landfill No. 3	9.9	7.0-12.0	+0.3	780	70-3,780	-670
Landfill No. 4	10.3	3.0-12.0	+0.3	990	240-2,340	-337
Golf Course (Well GC-1)	11.3	11.0&11.5	-0.5	1,370	1,080&1,660	-580

[1] Total ground water in-situ temperatures/conductivities averaged and ranged for February and April 1983 field measurements. Conductivity measurements rounded to the nearest ten's.

[2] Averaged change between February and April 1983 field measurements.

Table 2-5. In-Situ Ground-Water Temperature and Conductivity Measurements, Chemical Disposal Pits 1 & 2, Landfills 3 & 4 and Golf Course[1]

Monitor Well Number	Temperature		Specific Conductance	
	°C[2]	Change	µmhos @ 25°C[3]	Change
GC-1*	11.5 a	--	1,660	--
	11.0 b	-0.5	1,080	-580
M-1*	12.5 a	--	920	--
	11.0 b	-1.5	740	-180
M-2*	12.0 a	--	1,270	--
	11.0 b	-1.0	1,080	-190
M-3*	12.0 a	--	690	--
	12.0 b	0.0	560	-130
M-4*	12.0 a	--	1,140	--
	11.0 b	-1.0	630	-510
M-6*	10.5 a	--	590	--
	10.5 b	0.0	450	-140
M-7*	9.0 a	--	620	--
	12.0 b	+3.0	440	-180
M-9*	10.0 a	--	3,780	--
	7.0 b	-3.0	650	-3,130[4]
M-10*	9.0 a	--	1,120	--
	9.0 b	0.0	320	-800

(Continued)

Table 2-5. In-Situ Ground-Water Temperature and Conductivity Measurements, Chemical Disposal Pits 1 & 2, Landfills 3 & 4 and Golf Course[1]

Monitor Well Number	Temperature °C[2]	Temperature Change	Specific Conductance µmhos @ 25°C[3]	Specific Conductance Change
W-1	11.0 a	--	950	--
	9.5 b	-1.5	420	-530
W-2	10.5 a	--	900	--
	11.0 b	+0.5	410	-490
W-3	9.5 a	--	1,180	--
	9.5 b	0.0	540	-640
W-4	12.5 a	--	1,130	--
	12.0 b	-0.5	640	-490
W-7	11.0 a	--	500	--
	9.0 b	-2.0	330	-170
W-8	7.0 a	--	70	--
	9.0 b	+2.0	470	+400
W-9	2.0 a	--	140	--
	12.0 b	+10.0	370	+230
W-10	12.0 a	--	800	--
	10.0 b	-2.0	470	-330
W-11	10.0 a	--	1,030	--
	8.5 b	-1.5	490	-540

(Continued)

Table 2-5. In-Situ Ground-Water Temperature and Conductivity Measurements, Chemical Disposal Pits 1 & 2, Landfills 3 & 4 and Golf Course[1]

Monitor Well Number	Temperature °C[2]	Temperature Change	Specific Conductance µmhos @ 25°C[3]	Specific Conductance Change
W-12	10.0 a	--	960	--
	11.0 b	+1.0	570	-390
W-13	8.5 a	--	310	--
	7.0 b	-1.5	440	+130
W-14	Frozen a	--	--	--
	Frozen b	--	--	--
X-1	11.0 a	--	1,110	--
	11.0 b	0.0	550	-560
X-2	11.5 a	--	1,000	--
	10.0 b	-1.5	490	-510
X-3	11.0 a	--	950	--
	10.0 b	-1.0	500	-450
80-1	3.0 a	--	1,120	--
	7.5 b	+4.5	430	-690
80-2	8.0 a	--	680	--
	10.5 b	+2.5	490	-190
80-3	12.0 a	--	1,590	--
	10.0 b	-2.0	520	-1,070

(Continued)

Table 2-5. In-Situ Ground-Water Temperature and Conductivity Measurements, Chemical Disposal Pits 1 & 2, Landfills 3 & 4 and Golf Course[1]

Monitor Well Number	Temperature °C[2]	Temperature Change	Specific Conductance µmhos @ 25°C[3]	Specific Conductance Change
80-4	12.0 a	--	1,880	--
	11.0 b	-1.0	540	-1,340
80-5	12.0 a	--	1,060	--
	11.0 b	-1.0	490	-570
80-6	11.5 a	--	1,070	--
	10.0 b	-1.5	610	-460
80-7	12.0 a	--	1,130	--
	11.0 b	-1.0	1,350	+220
80-8	12.0 a	--	1,720	--
	12.0 b	0.0	1,060	-660
80-9	10.0 a	--	2,960	--
	13.0 b	+3.0	3,460	+500
80-10	10.5 a	--	1,120	--
	9.5 b	-1.0	490	-630
80-11	10.5 a	--	1,030	--
	8.5 b	-2.0	580	-450
80-12	8.0 a	--	410	--
	11.0 b	+3.0	1,240	+830

(Continued)

Table 2-5. In-Situ Ground-Water Temperature and Conductivity Measurements, Chemical Disposal Pits 1 & 2, Landfills 3 & 4 and Golf Course[1]

Monitor Well Number	Temperature		Specific Conductance	
	°C[2]	Change	μmhos @ 25°C[3]	Change
80-13	11.0 a	--	880	--
	10.5 b	-0.5	560	-320
80-14	11.0 a	--	1,080	--
	11.0 b	0.0	530	-550
80-15	10.5 a	--	930	--
	12.C b	+1.5	380	-550
80-16	10.0 a	--	1,030	--
	11.5 b	+1.5	510	-520
80-17	10.5 a	--	1,100	--
	12.0 b	+1.5	440	-610
80-18	No water a	--	No water	--
	No water b	--	No water	--
80-19	9.5 a	--	1,250	--
	11.5 b	+2.0	550	-700
80-20	13.0 a	--	1,040	--
	12.0 b	-1.0	640	-400
80-21	No data a	--	No data	--
	11.0 b	--	430	--

(Continued)

Table 2-5. In-Situ Ground-Water Temperature and Conductivity Measurements, Chemical Disposal Pits 1 & 2, Landfills 3 & 4 and Golf Course[1]

Monitor Well Number	Temperature °C[2]	Temperature Change	Specific Conductance µmhos @ 25°C[3]	Specific Conductance Change
80-22	15.0 a	--	1,850	--
	14.0 b	-1.0	1,790	-60
80-23	12.0 a	--	780	--
	12.0 b	0.0	580	-200
80-24	9.0 a	--	240	--
	11.5 b	+2.5	1,110	+870
80-25	11.5 a	--	2,340	--
	11.5 b	0.0	1,670	-670

* Denotes monitor wells completed (late 1982, early 1983) during the present Hill AFB IRP Phase II Field Investigation; all other monitor wells completed ∿1980 ("80" series), ∿1976 ("W" series) and earlier ("X" series).

1 In-situ well measurements were taken with a field conductivity/temperature meter and probe positioned in the well approximately midway between the wells measured static water level and total sounded depth.

2 Temperatures rounded to the nearest 0.5 C; "a" denotes measurements taken 2/23-25/83; "b" denotes measurements taken 4/18/83.

3 Specific conductance values are rounded to the nearest "10".

4 There is some question regarding the validity of this pair of readings. For comparison, the laboratory measurements of conductance were 4,500 (first) and 3,600 (second) with a difference of 900 µmhos at 25°C.

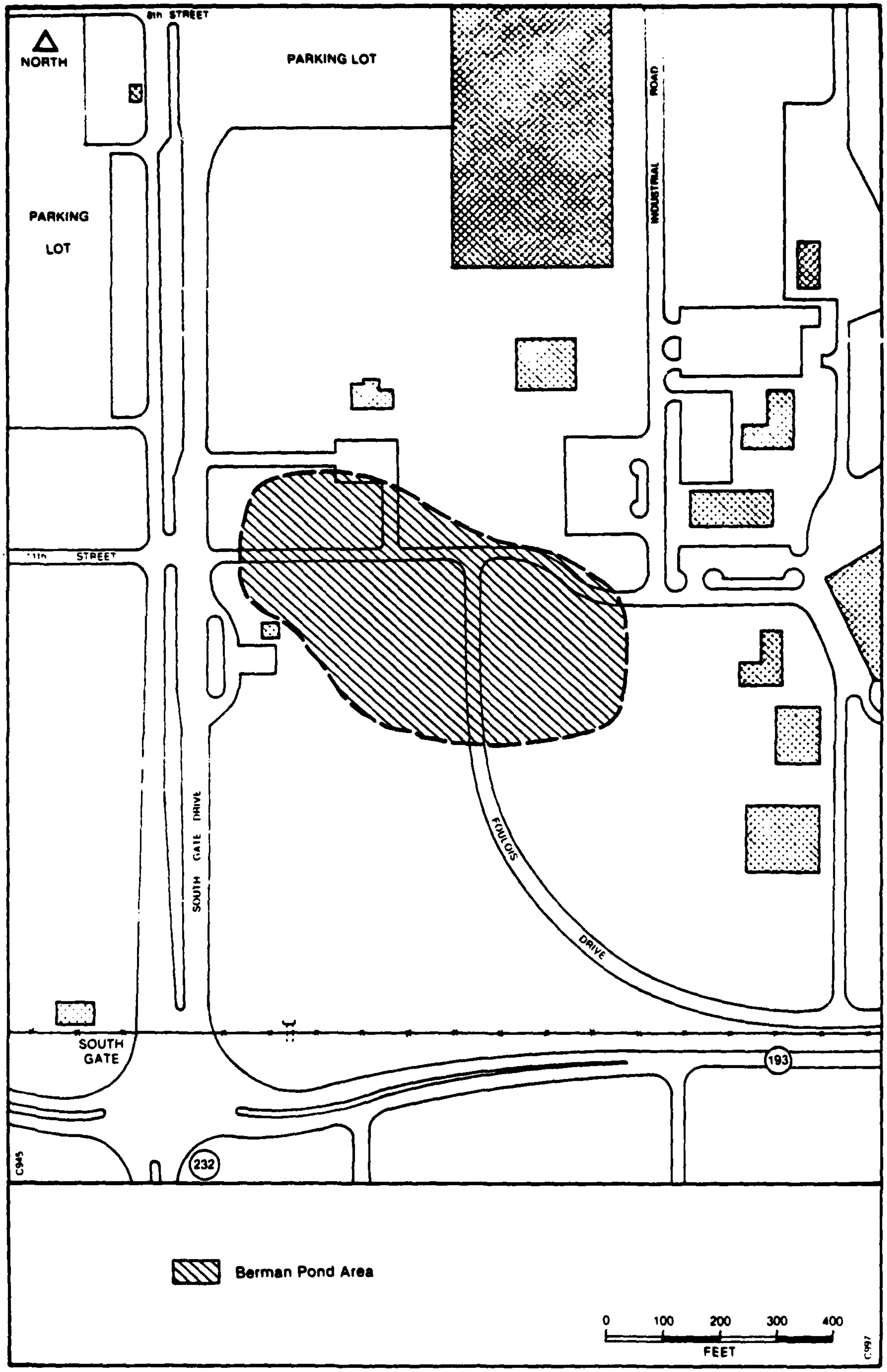

Figure 2-9. Location of Berman Pond

A hydrogeologic profile (location shown in Figure 2-10) was constructed from representative soil boring data and is displayed on Figure 2-11. Exhibit F is a corehole previously drilled by the Air Force. The supporting geologic log data for Berman Pond is provided in Appendix C. It becomes apparent from the profile that the geologic materials change quickly in relatively short distances and are difficult to correlate between the bore holes.

Water bearing zones and groundwater levels that were measured on 26 May 1983 are also shown on Figure 2-11 next to the logs for Berman Pond Monitor Well No. 1 and No. 2 (BPM-1 and 2.) There appear to be two separate aquifers, as suggested by the logs and aquifer performances during drilling, although it is possible that they are hydraulically connected. The groundwater at BPM-2 is distinctly artesian being capped by a clay section. This productive sand and gravel aquifer at BPM-2 probably represents an old Weber Delta stream channel.

In contrast, the groundwater at BPM-1 appears to occur under water-table or semi-artesian conditions. There may be a greater chance of hydraulic connection with the ground surface area than with the aquifer at BPM-2. The exact relationship cannot be inferred from the available data.

The groundwater level data for the monitor wells are shown on Figure 2-12 with the supporting data on Table 2-6. The supporting well locations are discussed in Section 2.5. There is a difference of about 31 feet in groundwater elvation between the two monitor wells which suggests that the two aquifers are not connected. Furthermore, the changes in static water levels between December 1982 and May 1983 at the two wells are quite different, -0.7 ft. at BPM-1 and +3.5 ft. at BPM-2. The magnitude of static water level change at BPM-2 resembles that which occurred at the Golf Course and neighboring study areas. Although not conclusive, this may indicate a possible hydraulic connection of the aquifer at BPM-2 with recharge east of Berman Pond from possibly the Hill AFB Golf Course area. This general side of the base has been noted in previous studies to be a possible recharge area to underlying aquifer systems (Engineering-Science, 1982)(Figure 2-1).

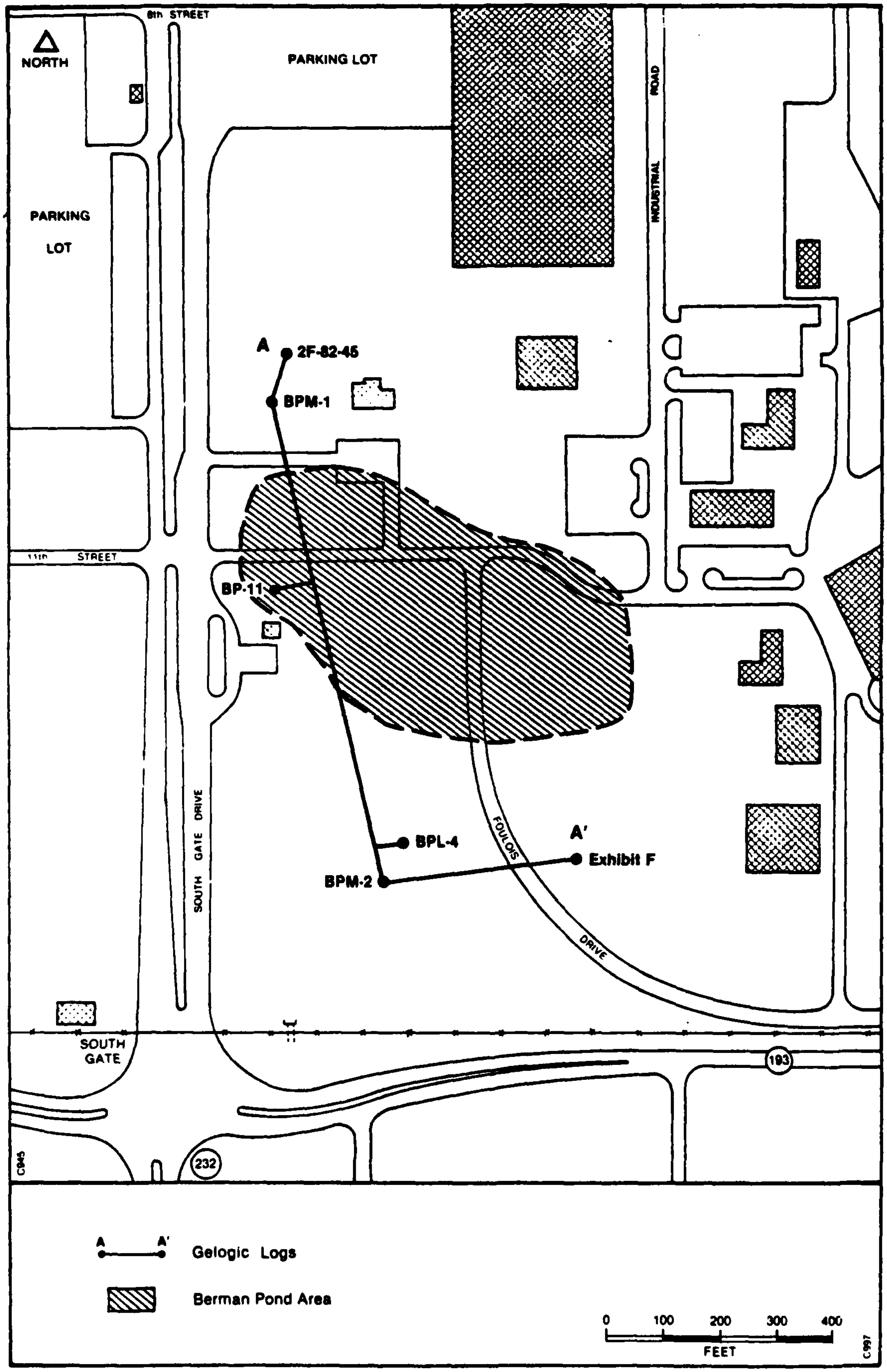

Figure 2-10. Location of Berman Pond Hydrogeologic Profile

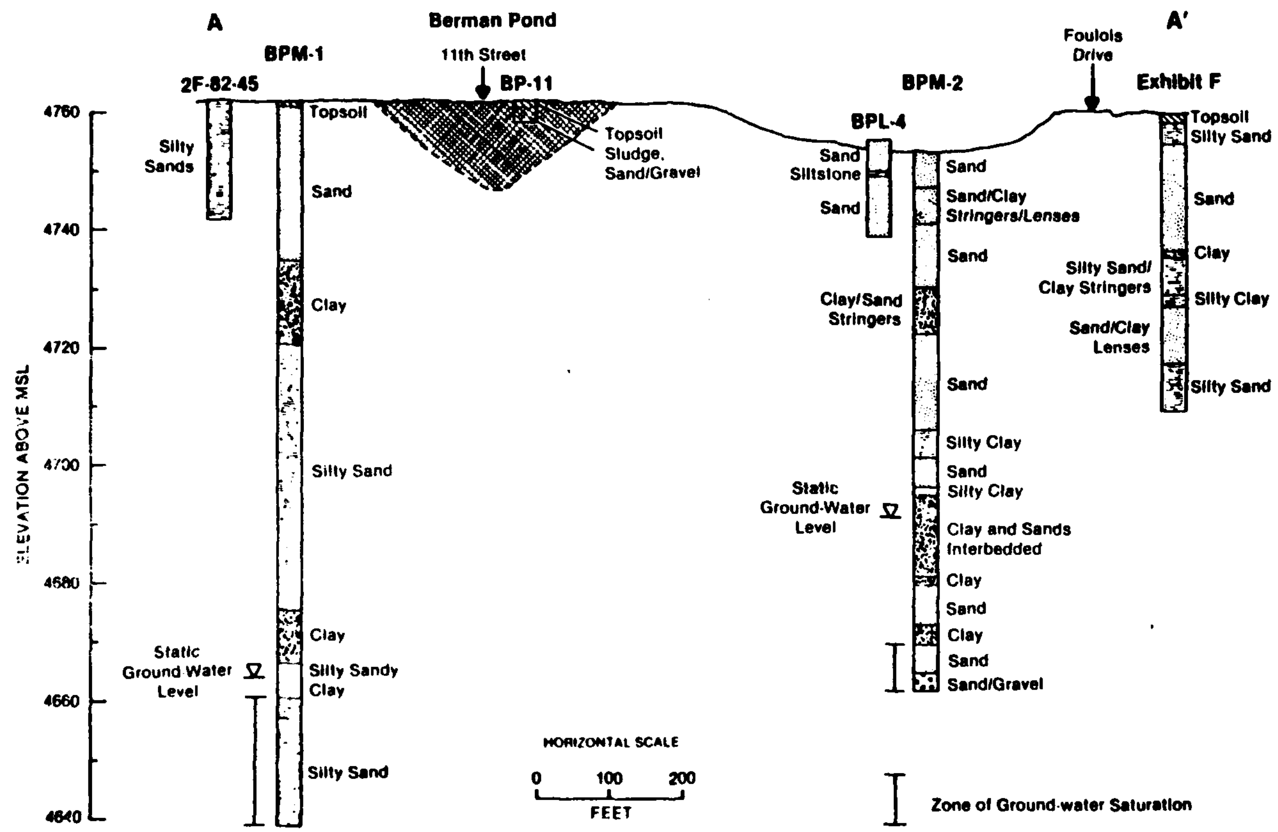

Figure 2-11. Representative Hydrogeologic Profile A-A', Berman Pond

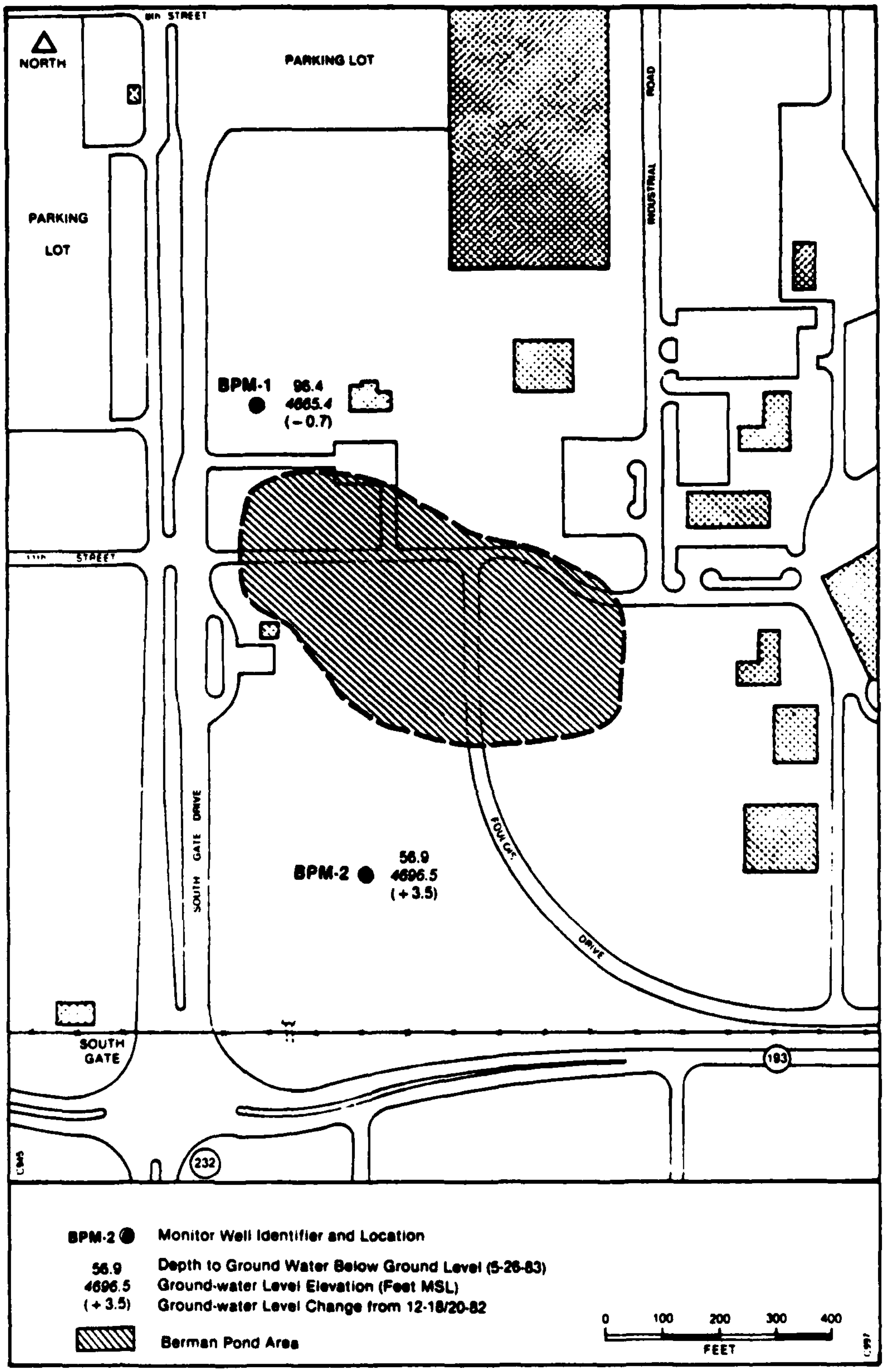

Figure 2-12. Ground-Water Level Data at Berman Pond.

Table 2-6. Selected Information on Monitor Wells and Ground-Water Levels in the Vicinity of Berman Pond

Monitor Well Number[1]	Depth to Water (Feet Below Measuring Point)[2]	Static Water Level Change (Feet)	Measuring Point Elevation (Feet MSL)[3]	Static Water Level Elevation (Feet MSL)	Measuring Point Height Above Ground Level (Feet)[4]	Ground Level Elevation (Feet MSL)	Depth to Water Below Ground Level (Feet)[5]
BPM-1	97.6 (12-18-82)		~4,763.9	4,666.3	~2.1	~4,761.8	95.5
	98.30 (5-26-83)	-0.7	4,763.70	4,665.4	1.9	4,761.8	96.4
BPM-2	61.8 (12-20-82)		~4,754.7	4,692.9	~1.3	~4,753.4	60.5
	58.30 (5-26-83)	+3.5	4,754.79	4,696.5	1.4	4,753.4	56.9

1/ Monitor Wells emplaced by Radian Corporation December 1982; Driller - Construction Drilling International, Salt Lake City, Utah.
2/ Selected static water level measurements obtained during Radian Corporation Hill AFB IRP Phase II Field Investigation.
3/ Measuring point elevation surveyed by Hill AFB Civil Engineers May 1983.
4/ Measuring point height above ground level from Radian Corporation Hill IRP Phase II Field Investigation.
5/ Aquifer intervals - BPM-1: ~101-122 1/2 feet below ground level
- BPM-2: 83-91 feet below ground level.

2.3.3 Hydrogeology of Chemical Disposal Pit No. 3

The area around Chemical Disposal Pit No. 3 is shown on Figure 2-13. The pit as found during the investigation consisted of two shallow trenches several feet wide and deep by about 90 to 130 feet long. The site is situated on or near the head of a slump feature which is part of a larger series of features called the South Weber landslide complex (Pashley, 1971). The South Weber landslide complex is a series of landslides which occurred along the bluff on the north side of the Base. The complex is approximately located in the area between Chemical Disposal Pits Nos. 1 and 2 and the Base north gate (Figure 1-1). Past earth movements have been essentially down the bluff towards the South Weber River. The Davis-Weber Canal is located on the slide debris. The hydrogeology associated with slumps is generally extremely complex (Schuster, 1978); this appears to be true for the Chemical Disposal Pit No. 3 area.

In order to better understand the structural and geological conditions at the site and to evaluate the hydrogeology, four geologic cross sections were constructed. The locations of the profiles are shown on Figure 2-14, along with the locations of the piezometers and lysimeters emplaced during this study. The detailed profiles are depicted on Figure 2-15 and Figure 2-16. The supporting geological logs are compiled in Appendix C. It can be seen that lithologic and hydrologic changes occur over very short distances (measured in tens of feet) both vertically and horizontally.

The lithology of the site mainly consists of sands, gravels and clays. There are two distinct clays that were distinguished by their color during hollow-stem auger sampling. The shallowest clays were a brown to reddish brown while the slightly deeper clays tended to be gray to grayish brown in color. In all instances when the gray clays were encountered, they were under and appeared to be in contact with the red clays. The contact was not easily determined but inferred through the boring logs, geomorphology, hydrology and geophysics. This contact between the two clays appears to be either a contact generated by the slumping process (i.e., fault), or a natural lithologic contact. The red

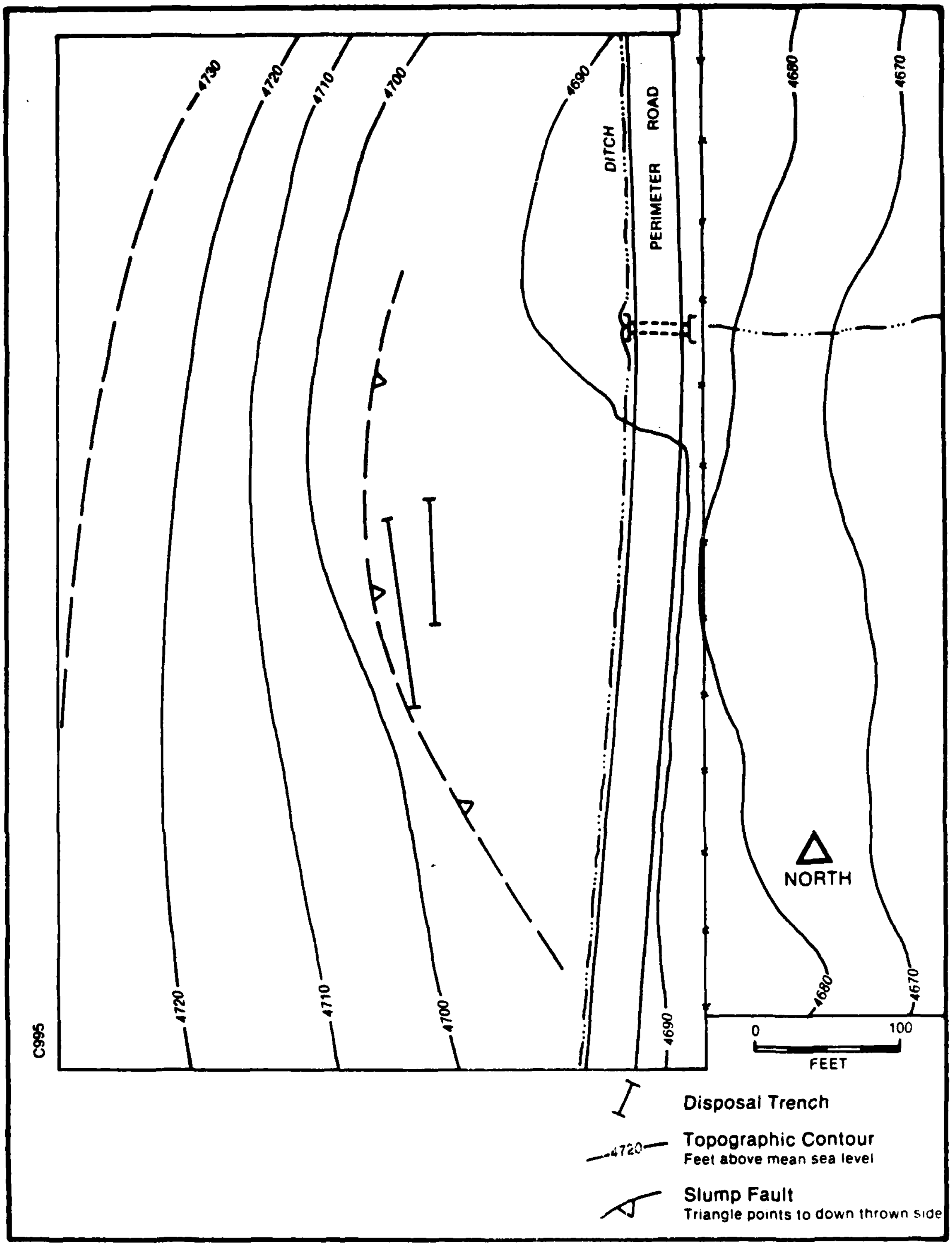

Figure 2-13. Location of Chemical Disposal Pit No. 3.

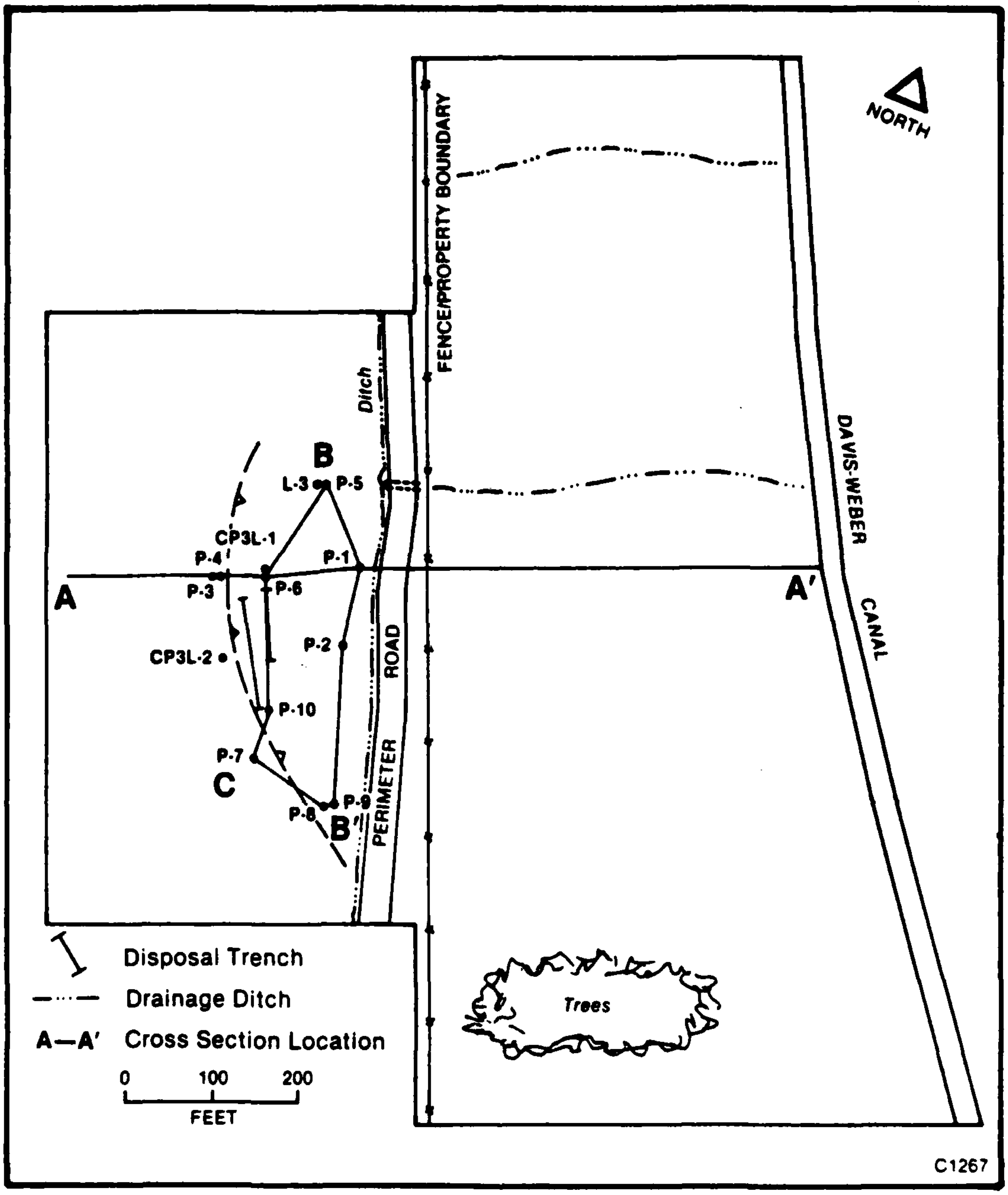

Figure 2-14. Locations of Hydrogeologic Cross-Sections, Chemical Disposal Pit No. 3.

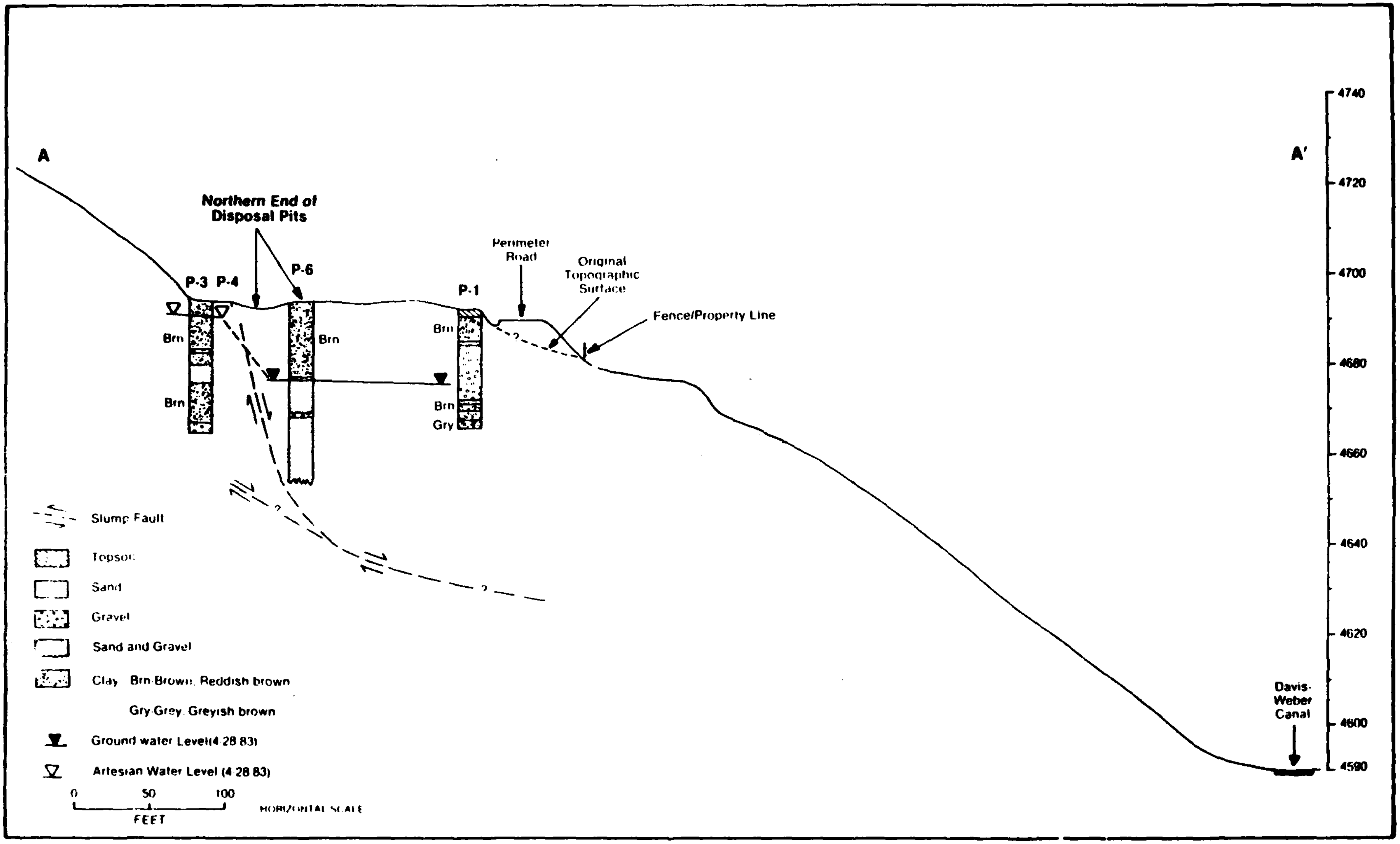

Figure 2-15. Hydrogeologic Profile A-A' Chemical Disposal Pit No. 3

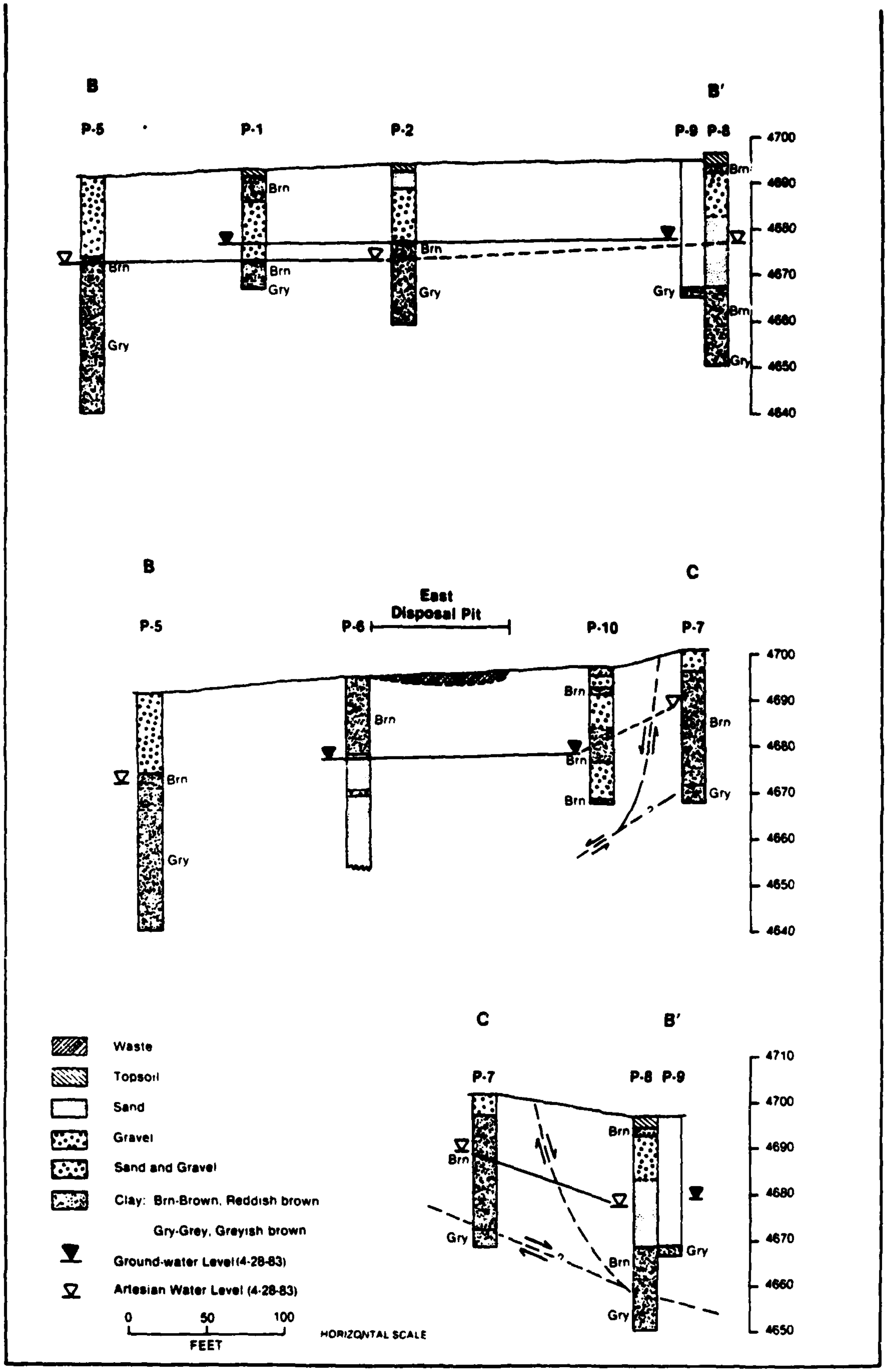

Figure 2-16. Hydrogeologic Profiles B-B', B-C, C-B' Chemical Disposal Pit No. 3

clay was also found to be more hydroscopic than the gray clay. The significance of the contact became apparent upon completion of the ten piezometers at the site, four of which were completed in the clays. Groundwater moves along the contact between the clays. Perched groundwater was also found in the sand and gravels up slope and down slope of the fault depicted on Figure 2-13.

Hydraulic head analyses combined with the other site data noted above permitted the determination of two aquifer systems. Therefore, the site hydrogeology consists of locally perched water table and artesian aquifer systems which are hydraulically interconnected through the complex structure of the slump feature. The perched system occupies sand and gravel layers within the slump block directly under the "pit." The artesian system occupies the slip planes under the "pit" and west of the fault located between Piezometers P-7 and P-10, and between P-7 and P-8 (Figure 2-16). The drop in static water level elevation across the fault between Piezometers P-4 and P-6 (shown on Profile A-A' on Figure 2-15) and similarly in the area of Piezometer P-7 on Profiles B-C and C-B' (Figure 2-16) implies that the area along the fault acts as a barrier to groundwater flow. Profiles B-B', B-C and C-B' show the relative static water level differences between the slump perched water table sytem and the artesian slip plane system. Piezometers P-2, P-5, P-7 and P-8 were completed in the clays and reflect the hydraulic head associated with the perched system. Piezometer P-3 and P-4 (Figure 2-15) were completed in confined sands or gravels but are part of the slump artesian system west of the fault. All of the other Piezometers (P-1, P-6, P-9, P-10) were completed in the slump perched water table system.

Static water level data were collected in February and April of 1983. The April 1983 measurements were found to show the full impact of the unusual amount of winter precipitation. The April 1983 static water level contours for the slump perched aquifer are depicted on Figure 2-17; while contours of the underlying artesian portion of the slump system are shown on Figure 2-18. The supporting data are contained in Table 2-7. The general flow direction in both systems is locally to the northeast, based upon the groundwater level contours. Since the perched water table

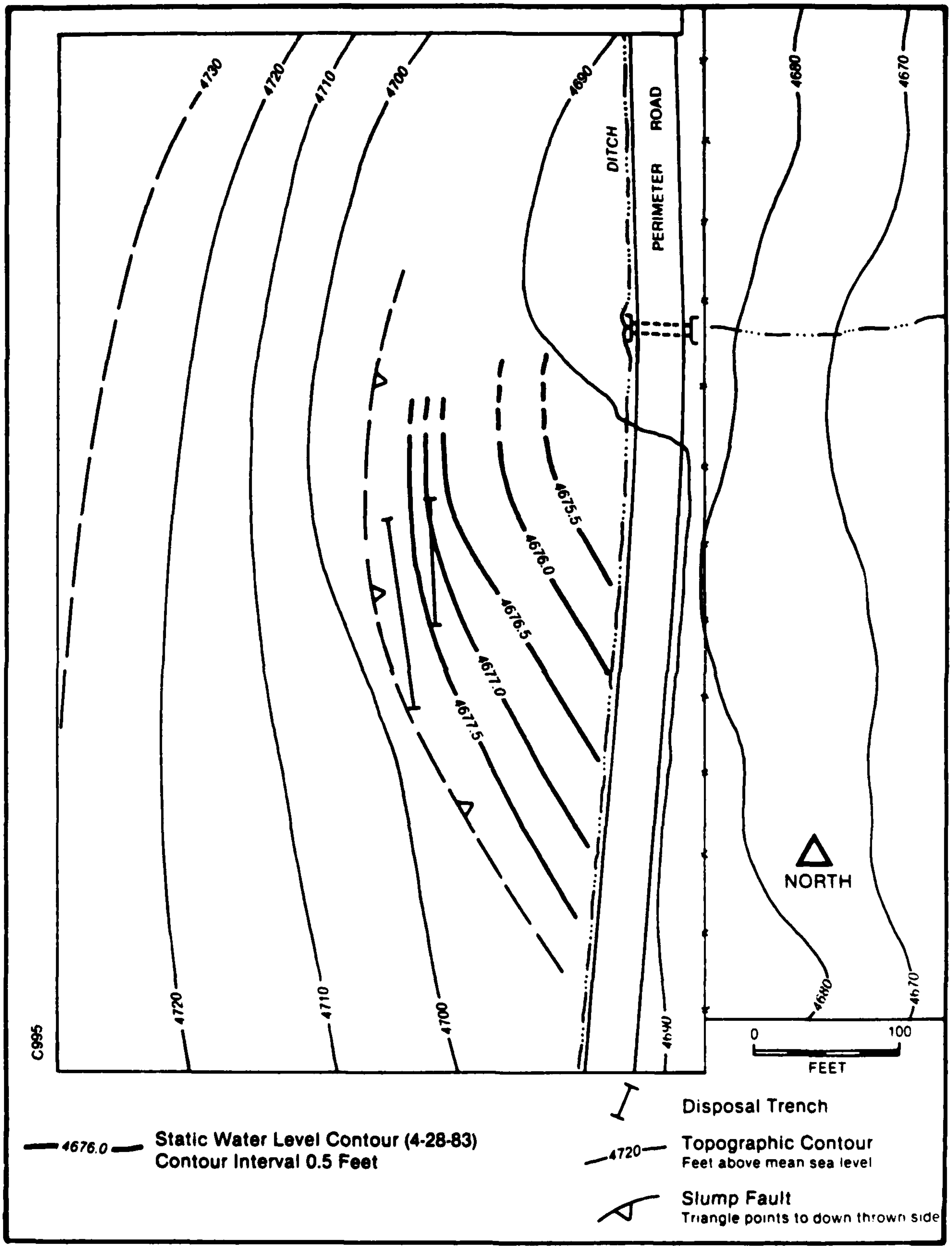

Figure 2-17. Elevation of Perched Ground-Water Table, Chemical Disposal Pit No. 3.

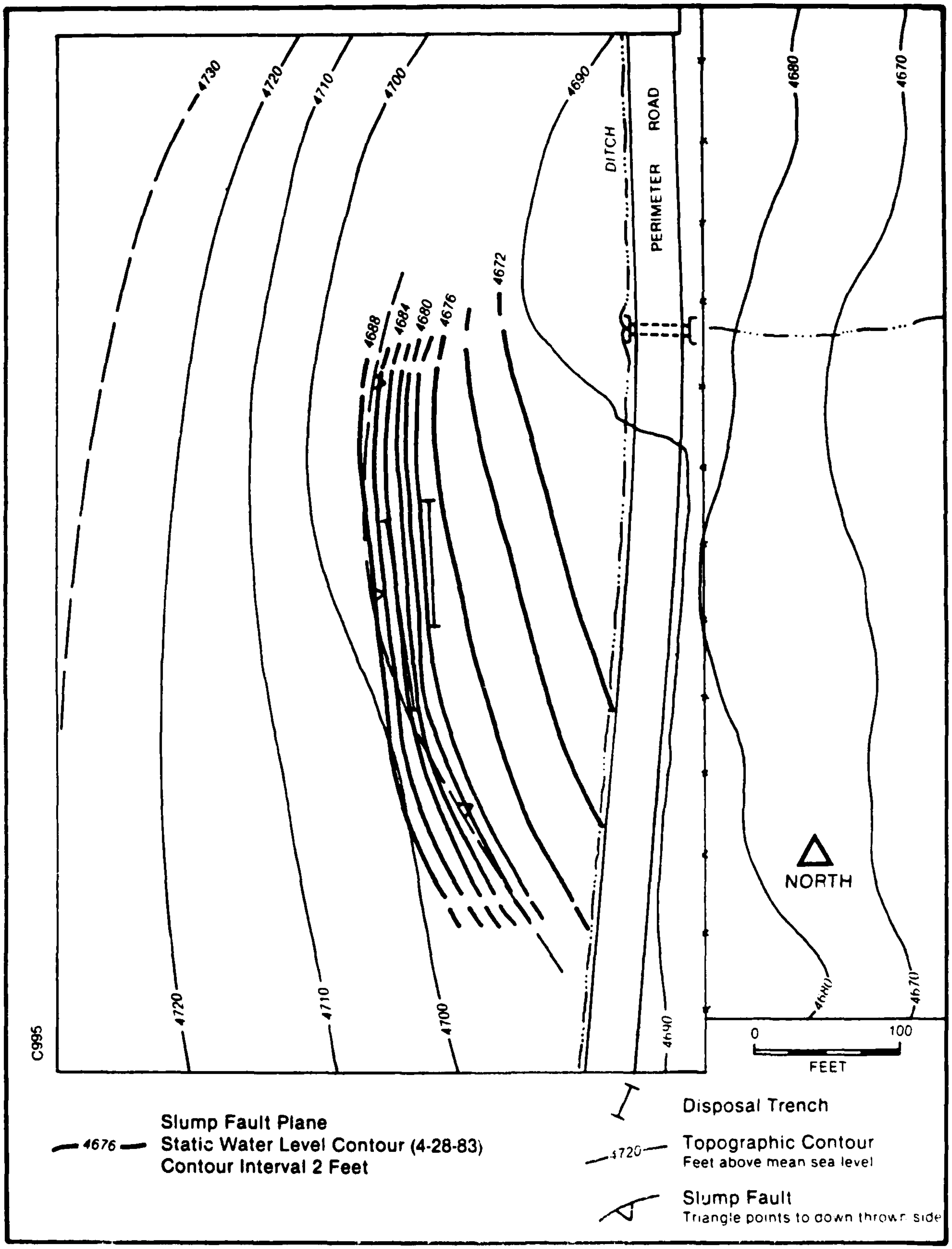

Figure 2-18. Ground-Water Level Contours of Slump Fault Plane Artesian Aquifer, Chemical Disposal Pit No. 3.

Table 2-7. Selected Information on Piezometer and Ground-Water Levels in the Vicinity of Chemical Disposal Pit No. 3

Piezometer Number[1]	Depth to Water (Feet Below Measuring Point)[2]	Static Water Level Change (Feet)	Measuring Point Elevation (Feet MSL)[3]	Static Water Level Elevation (Feet MSL)	Measuring Point Height Above Ground Level (Feet)[4]	Ground Level Elevation (Feet MSL)	Depth to Water Below Ground Level (Feet)
P-1	19.74 (2-25-83)		4,693.46	4,673.7	2.0	4,691.5	17.7
	18.37 (4-28-83)	+1.37	4,693.46	4,675.1	2.0		16.4
P-2	23.84 (2-25-83)		4,695.73	4,671.9	1.9	4,693.8	21.9
	23.02 (4-28-83)	+0.82	4,695.73	4,672.7	1.9		21.1
P-3	10.53 (2-25-83)		4,696.00	4,685.5	1.6	4,694.4	8.9
	4.73 (4-28-83)	+5.80	4,696.00	4,691.3	1.6		3.1
P-4	10.59 (2-25-83)		4,696.15	4,685.6	2.4	4,693.8	8.2
	4.90 (4-28-83)	+5.69	4,696.15	4,691.3	2.4		2.5
P-5	22.36 (2-25-83)		4,692.10	4,669.7	2.1	4,690.0	20.3
	21.18 (4-28-83)	+1.18	4,692.10	4,670.9	2.1		19.1
P-6	21.53 (2-25-83)		4,695.68	4,674.2	1.6	4,694.1	19.9
	19.15 (4-28-83)	+2.38	4,695.68	4,676.5	1.6		17.6
P-7	17.70 (2-25-83)		4,700.86	4,683.2	1.3	4,699.6	16.4
	13.59 (4-28-83)	+4.11	4,700.86	4,687.3	1.3		12.3
P-8	24.12 (2-25-83)		4,697.13	4,673.0	1.4	4 695.7	22.7
	20.56 (4-28-83)	+3.56	4,697.13	4,676.6	1.4		19.1
P-9	23.38 (2-25-83)		4,696.91	4,673.5	2.0	4 694.9	21.4
	19.38 (4-28-83)	+4.00	4,696.91	4,677.5	2.0		17.4
P-10	24.87 (2-25-83)		4,699.01	4,674.1	1.7	4,697.3	23.2
	21.21 (4-28-83)	+3.66	4,699.01	4,677.8	1.7		19.5

[1] Piezometers emplaced by Radian Corporation January 1983; Driller - Earth Exploration & Drilling, Bountiful, Utah.
[2] Selected static water level measurements obtained during Radian Corporation Hill AFB IRP Phase II Field Investigation.
[3] Measuring point elevation surveyed by Hill AFB Civil Engineers, May, 1983.
[4] Measuring point height above ground level from Radian Corporation Hill IRP Phase II Field Investigation before emplacement of protective surface casing.

aquifer appears to be lithologically controlled, flow directions may be influenced by lithologic changes off-site; however, flow would still be expected to move toward the Weber River Valley. Groundwater in the artesian system, being structurally controlled, will flow towards the river valley, but the detailed flow directions will be controlled by the exact nature of the slump faults and any asymmetry associated with the features.

Changes in groundwater levels for both aquifer systems are shown on Figure 2-19. The supporting data are on Table 2-7. The contours show the greatest water level increase along and west of the fault, decreasing east of the fault. This further suggests that the fault acts as a barrier to groundwater flow, although the changes in water levels east of the fault do indicate that there is some hydraulic communication between the perched and artesian systems.

In situ measurements of temperature and conductivity in groundwater were taken during the field investigation to further aid in delineating the hydrogeologic system. These data are summarized on Table 2-8 along with lab conductivity measurements from the second sampling episode. The in-situ temperatures are shown on Figure 2-20. The figure also depicts the specific measurements of temperature and temperature change from 2/25/83 to 4/28/83, while Figure 2-21 depicts the laboratory conductivity measurements. The lab measurements were used to verify and calibrate the field measurements while providing one set of data without field measurement "noise."

Groundwater temperatures can be used as an indication of the groundwater flow pattern by delimiting the thermal front from significant recharge. On the other hand, the groundwater level changes previously noted give a good indication of the hydraulic pressure response of the aquifer. The coolest temperatures of 9°C and 10°C are along, and west of the fault. These observations support the conclusions drawn from the piezometer measurements. The area along the 11°C line are from piezometers mostly completed in a sand horizon (P-9, P-10, P-6, and P-1) which is more permeable than the clay zones tapped by Piezometers P-8, P-2, and P-5. The in-situ conductivity data on Table 2-8 indicate that the

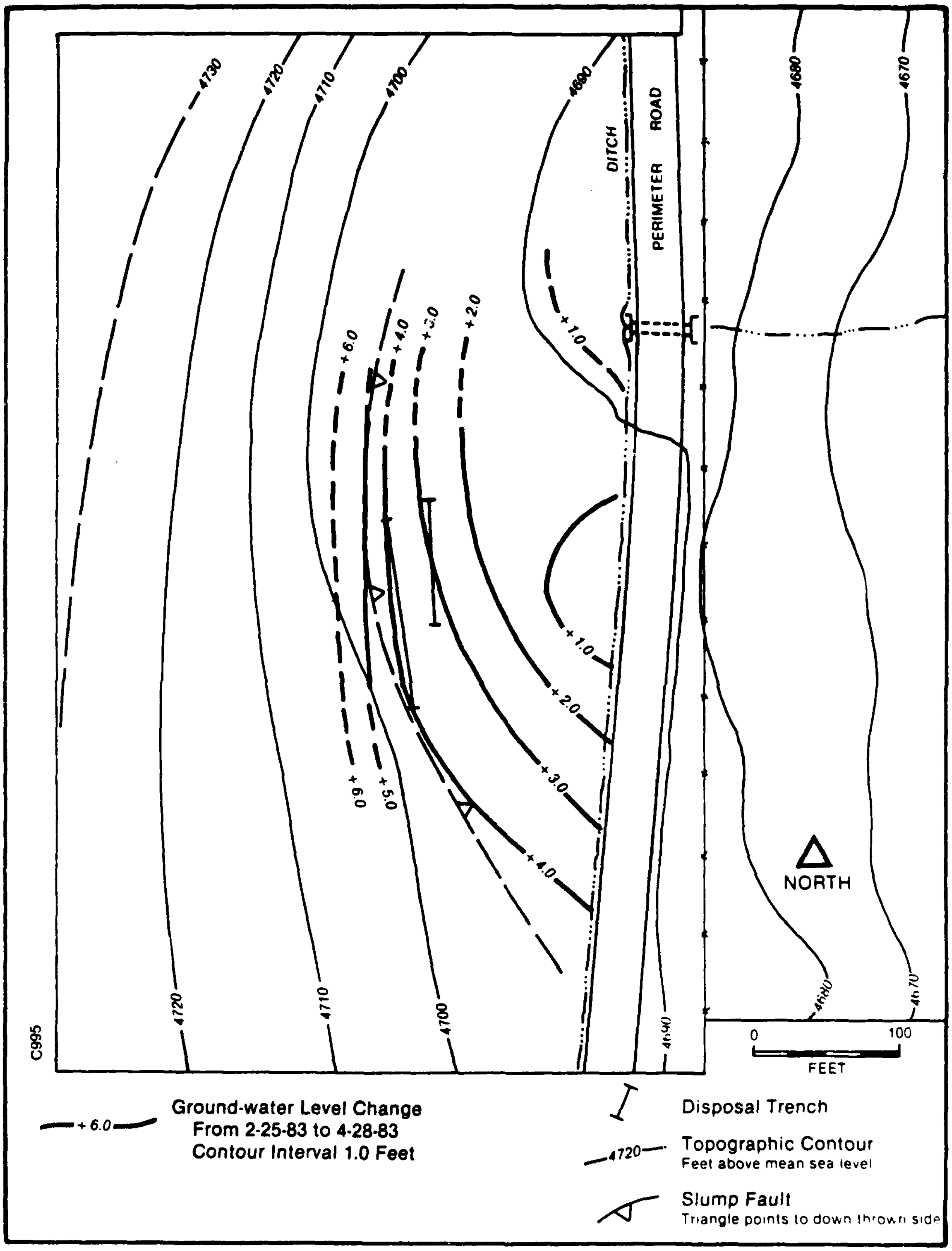

Figure 2-19. Ground-Water Level Changes at Chemical Disposal Pit No. 3.

Table 2-8. Chemical Disposal Pit No. 3 In-Situ Ground-Water Temperature and Conductivity Data[1]

Piezometer Number	Date	Field Ground-Water Temperature (°C)	Temperature Change (°C)	Conductivity (µmhos/cm @ 25°C) Field	Conductivity (µmhos/cm @ 25°C) Lab[2]	Field Conductivity Change (µmhos/cm)
P-1	2/25/83	11.5	--	870	--	--
	4/28/83	10.0	-1.5	1,870	3,300	+1,000
P-2	2/25/83	12.5	--	1,080	--	--
	4/28/83	12.0	-0.5	990	920	-90
P-3	2/25/83	10.0	--	1,130	--	--
	4/28/83	9.0	-1.0	620	950	-510
P-4	2/25/83	9.0	--	1,190	--	--
	4/28/83	8.6	-0.4	590	950	-600
P-5	2/25/83	12.0	--	990	--	--
	4/28/83	11.5	-0.5	830	820	-160
P-6	2/25/83	12.0	--	1,270	--	--
	4/28/83	11.0	-1.0	1,010	1,200	-260
p-7	2/25/83	12.0	--	1,520	--	--
	4/28/83	10.8	-1.2	980	1,000	-540
P-8	2/25/83	12.0	--	800	--	--
	4/28/83	11.2	-0.8	590	650	-210
P-9	2/25/83	11.5	--	780	--	--
	4/28/83	10.5	-1.0	560	640	-220
P-10	2/25/83	12.8	--	1,540	--	--
	4/28/83	11.0	-1.8	1,080	1,200	-460

[1] Measurements taken inside piezometers mid-point between the static water level and sounded bottom.

[2] UBTL laboratory measurements (second round of sampling).

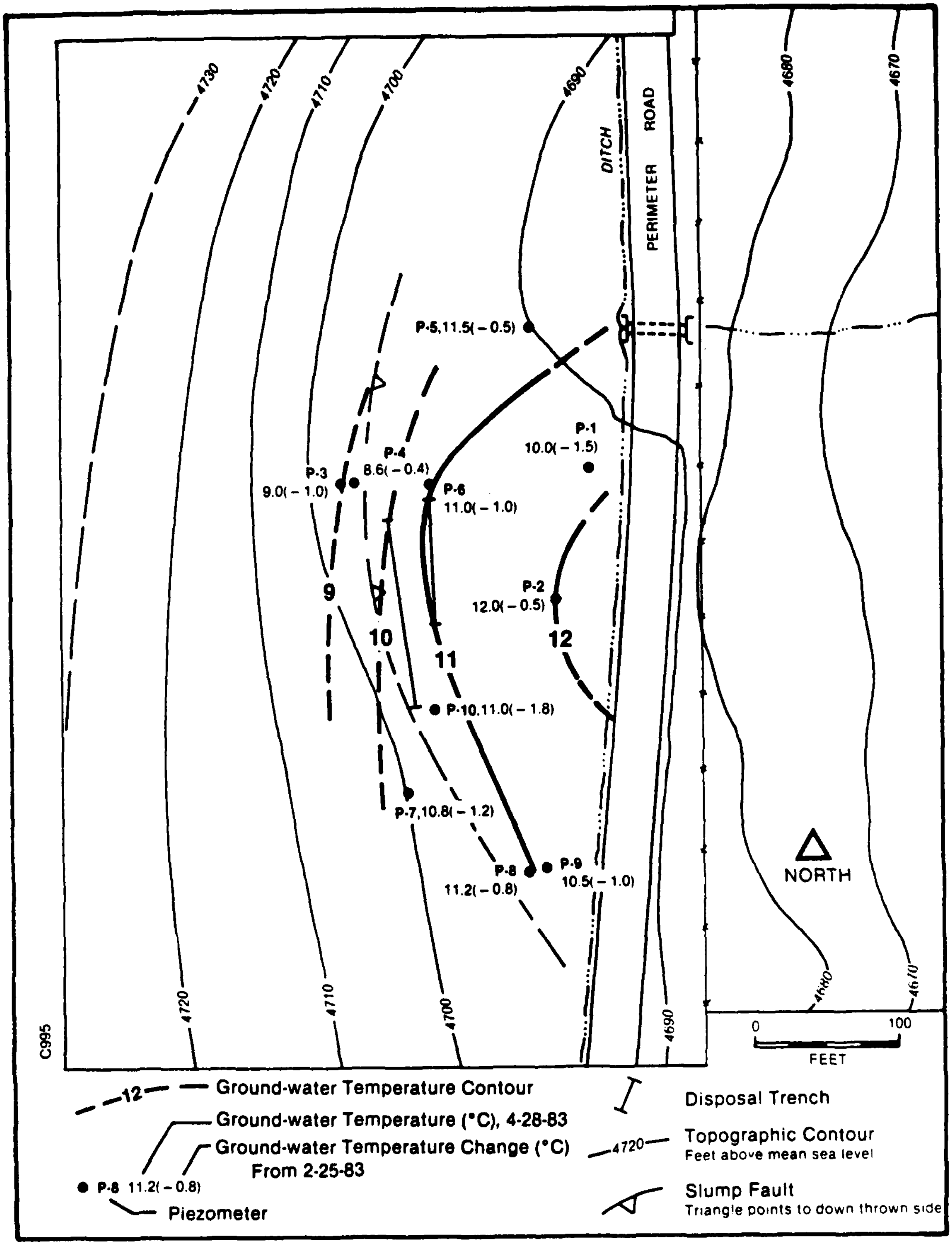

Figure 2-20. Ground-Water Temperatures Chemical Disposal Pit No. 3.

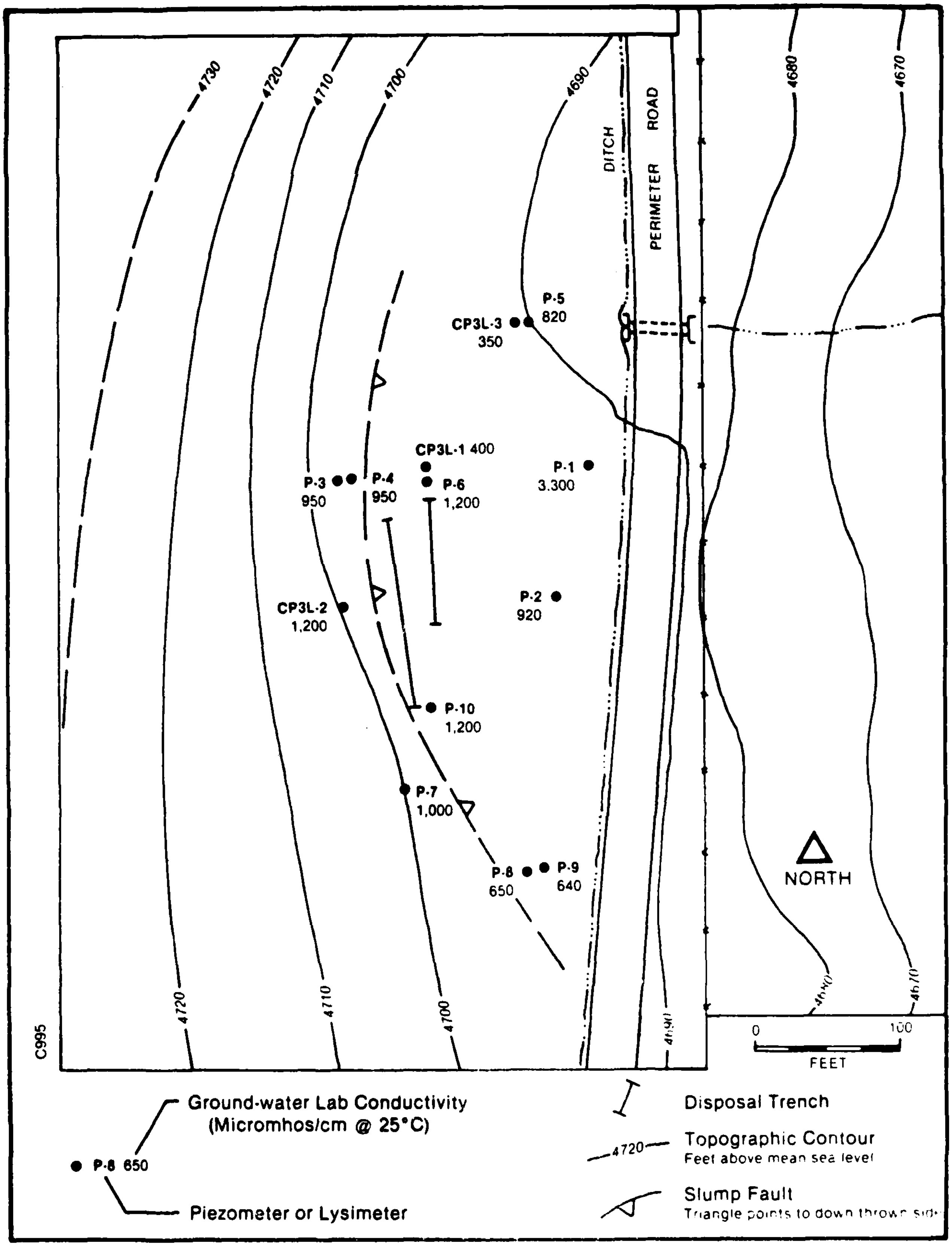

Figure 2-21. Ground-Water Conductivity Data, Chemical Disposal Pit No. 3.

conductivity decreased from February 1983 to April 1983 throughout the site, with the exception of Piezometer P-1, which showed an increase. The general decrease in conductivity is attributed to winter precipitation and groundwater recharge. The measurements provide qualitative insight into the possible rapid chemical changes during recharge. Lysimeter CP3L-1, which is only about two feet below the ground, had a laboratory conductivity of 400 micro-mhos/cm, which represents conductivities associated with winter precipitation and snow melt. The relatively higher conductivity values associated with the deeper lysimeters and piezometers indicate that some mineralization is occurring over short distances as the water moves down and through the ground. This mineralization can be caused by factors such as natural lithologic and hydrologic conditions or ground disturbances as well as a contamination source. Piezometer P-1 was the only in-situ measurement on Table 2-8 that showed an increase in field conductivity value. This is believed to be due to the upgradient subsurface disturbances of the aquifer and solvent product at Piezometers P-6 and P-10 due to augering and development activities. There is also a possibility that the measurement is the result of field meter error.

2.4 Historic Groundwater Problems

There are no known environmental complaints concerning the waste sites of Chemical disposal Pits Nos. 1 & 2, Landfill No. 3, Berman Pond and Chemical Disposal Pit No. 3 studied under the IRP Phase II Field Investigation. Landfill No. 4, which is close to Landfill No. 3 and not quite as close to Chemical Disposal Pits Nos. 1 & 2, has been the subject of complaints concerning groundwater contamination. The apparently contaminated leachate attributed to Landfill No. 4 reaches the ground surface through a number of seeps north-east and downslope of the base (Figure 2-4).

Several studies have been conducted to determine groundwater conditions in the vicinity of Landfill No. 4 and to assess the degree of contamination from the disposal activities (Calscience Research, 1981; OEHL, 1976). The analytical data from the studies indicate that some of the water sampled contained high concentrations of COD, BOD, iron, and

phenols. Monitoring of the seeps and periodic groundwater measurements are an ongoing Air Force effort. Design is complete; construction is currently underway for installation of an impermeable cap over Landfill No. 4 (Engineering-Science, 1982).

Although Chemical Disposal Pit Nos. 1 and 2 have not had any complaints associated with them, there has been an "oil slick" detected in two monitor wells installed before this study. (W-4 and 80-20). The presence of oil in these wells has been noted since about 1976 to the present (OEHL, 1976; Calscience, 1981; Davis, 1982). No detailed studies have been conducted.

The "oil" slick on top of the groundwater was measured in Monitor Well No. 4 in November 1982 during this investigation. The detected oil thickness was about 0.5 feet. A subsequent measurement in May 1983 indicated "zero" oil thickness but still oil in Monitor Well 80-20 upgradient. It is believed that the oil in W-4 has been mobilized due to the unusual water year which Utah experienced during 1982-1983.

Since the disposition of the oil was unknown, an extended water level and oil thickness measurement program around Chemical Disposal Pits Nos. 1 & 2 was recommended and accepted by the Air Force. The purpose of this limited program was to document the oil horizontal and vertical movement(s). This initial field effort occurred from July to mid November 1983. During this program no lateral migration of the oil slick beyond Monitor Wells W-4 and 80-20 was detected. It appears that much of the free soil on the groundwater surface was captured in the formation in response to the unusual rise in groundwater levels. The groundwater levels rose due to the large amount of winter precipitation the area received during the 1982-1983 winter season.

2.5 Locations of Wells and Borings

There was a wide range in the amount of well and soil boring information available for the various sites. The greatest quantity of information was available for Landfill No. 3 and Chemical Disposal Pits Nos. 1 & 2. The data were available because of the proximity of those

areas to the previously studied Landfill No. 4. Shallow foundation borings were available for Berman Pond. This information did not address deeper strata. Chemical Disposal Pit No. 3 was an unstudied site, requiring the complete development of a data base to address the environmental setting. Data from a total of 71 on-base production and monitor wells and 76 soil borings were utilized to develop the environmental setting. The logs and data are summarized in Appendix C.

The locations of most of the various on-base monitor wells, piezometers, lysimters and soil borings at each site used to develop the data base are presented as follows:

- Chemical Disposal Pits Nos. 1 & 2 (Figures 2-22 and 2-23);
- Landfill No. 3 (Figure 2-23)
- Golf Course (Figure 2-23)
- Berman Pond (Figure 2-24); and
- Chemical Disposal Pit No. 3 (Figures 2-25 and 2-26)

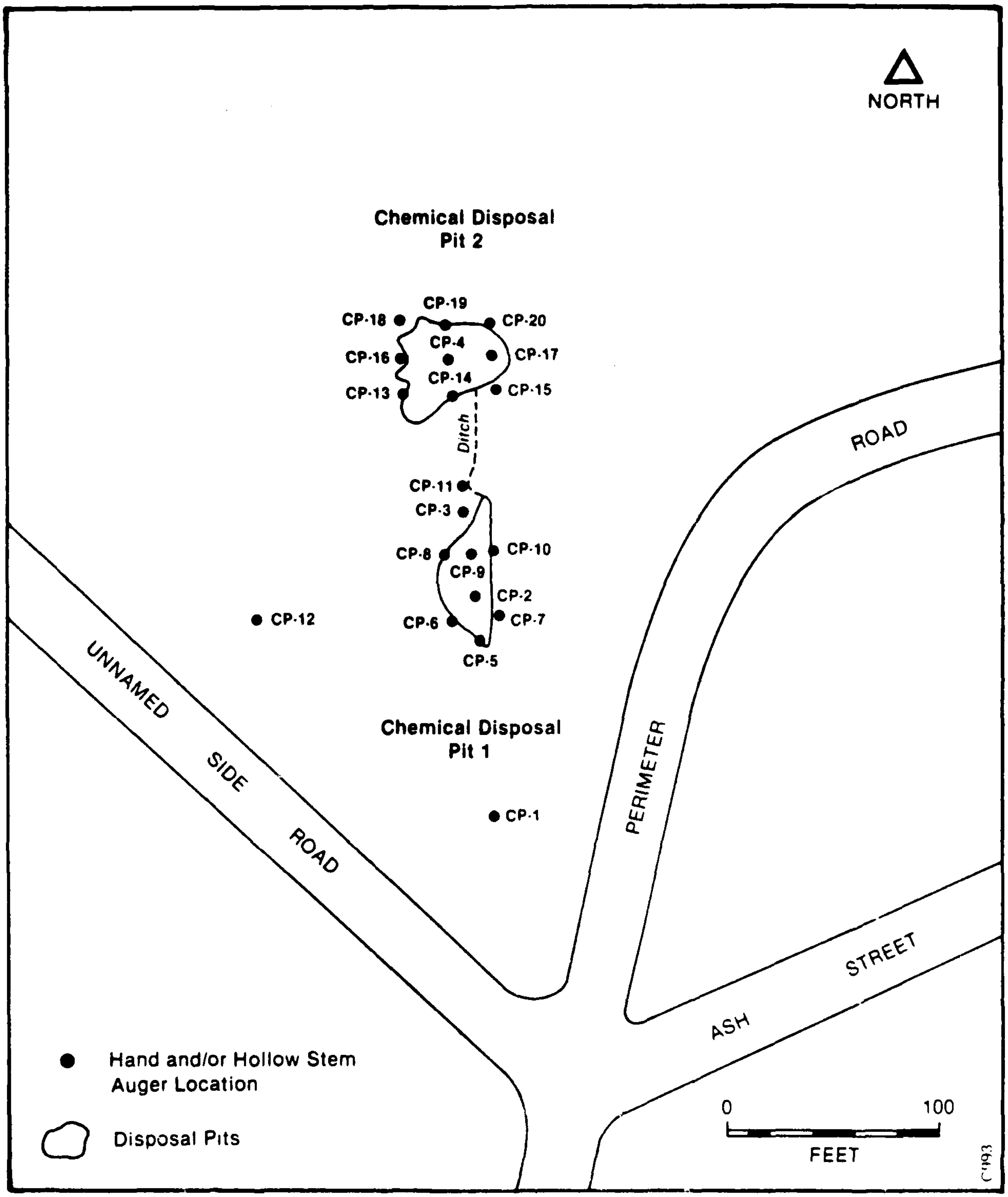

Figure 2-22. Auger Locations, Chemical Disposal Pit Nos. 1 and 2.

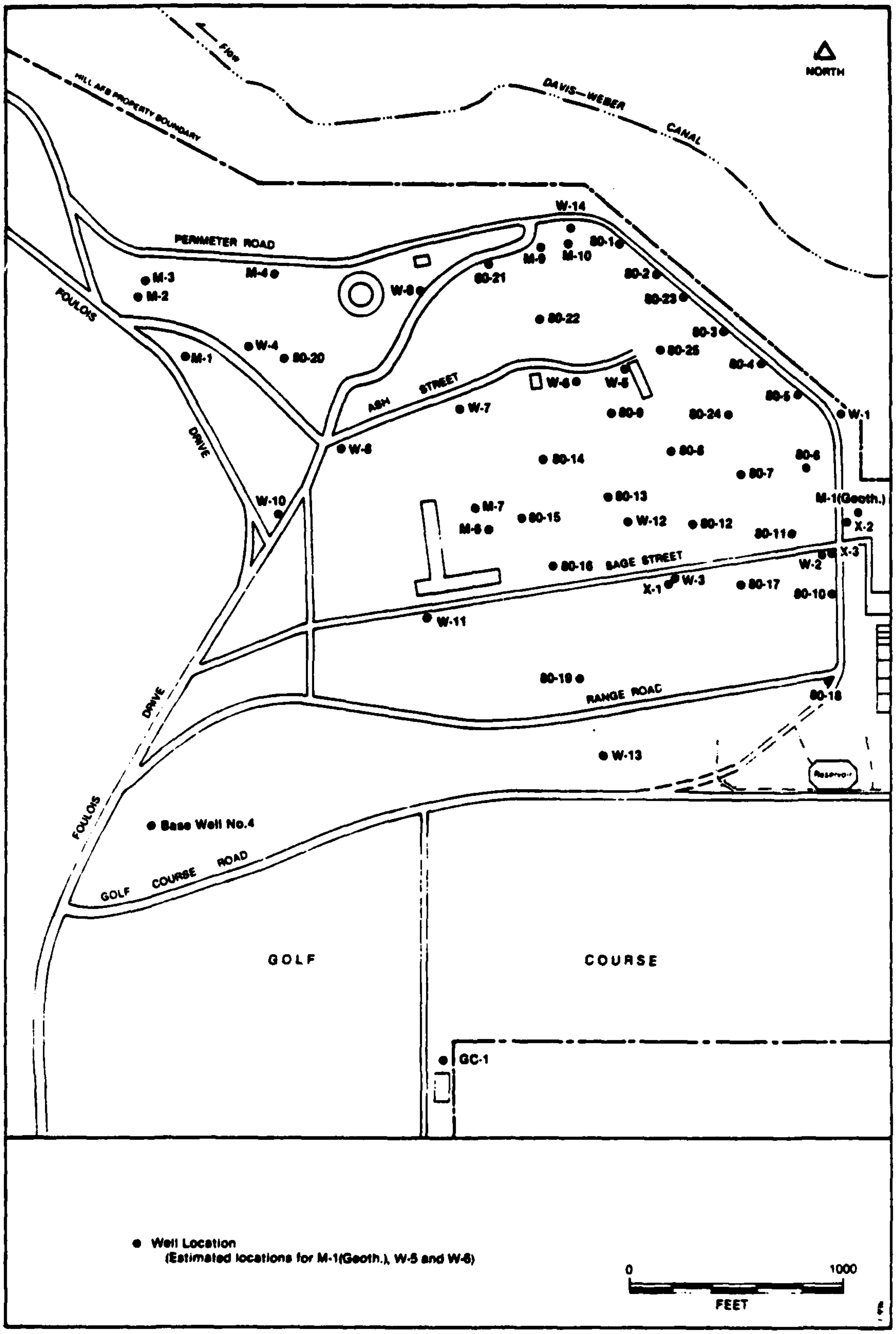

Figure 2-23. Well Locations in the Vicinity of Chemical Disposal Pits Nos. 1 and 2, Landfill No. 3 and Golf Course.

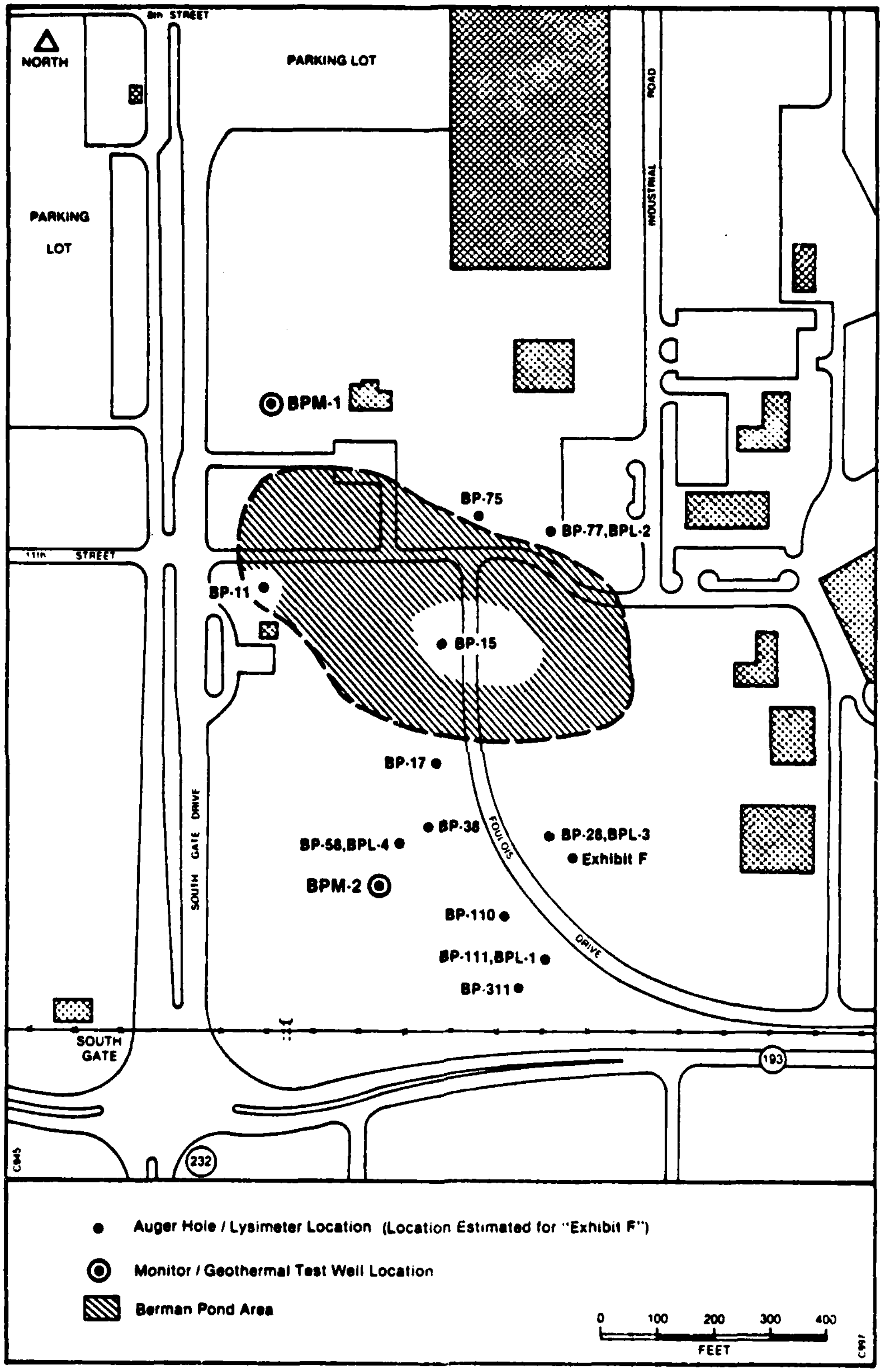

Figure 2-24. Well and Soil Augering Locations, Berman Pond.

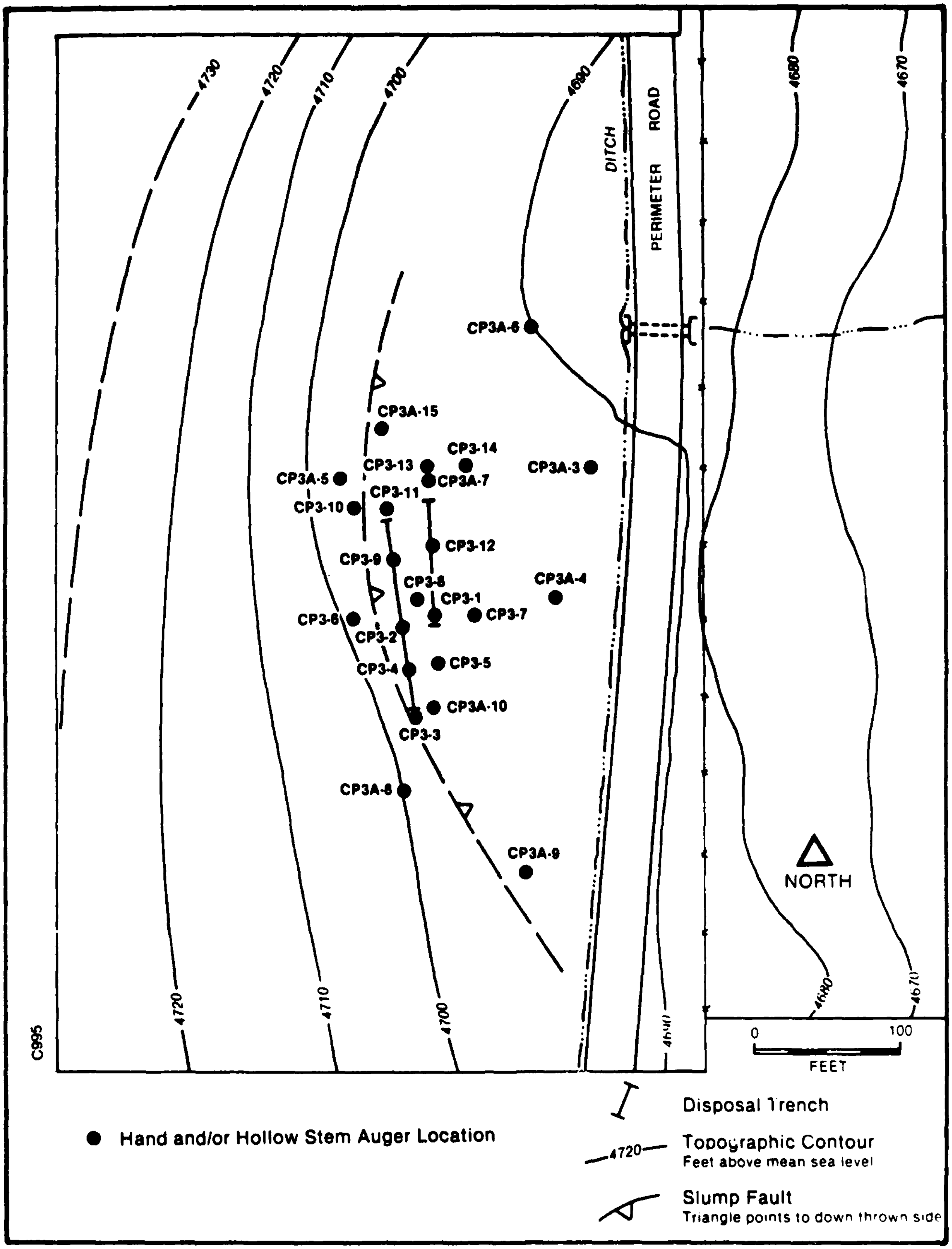

Figure 2-25. Auger Locations, Chemical Disposal Pit No. 3.

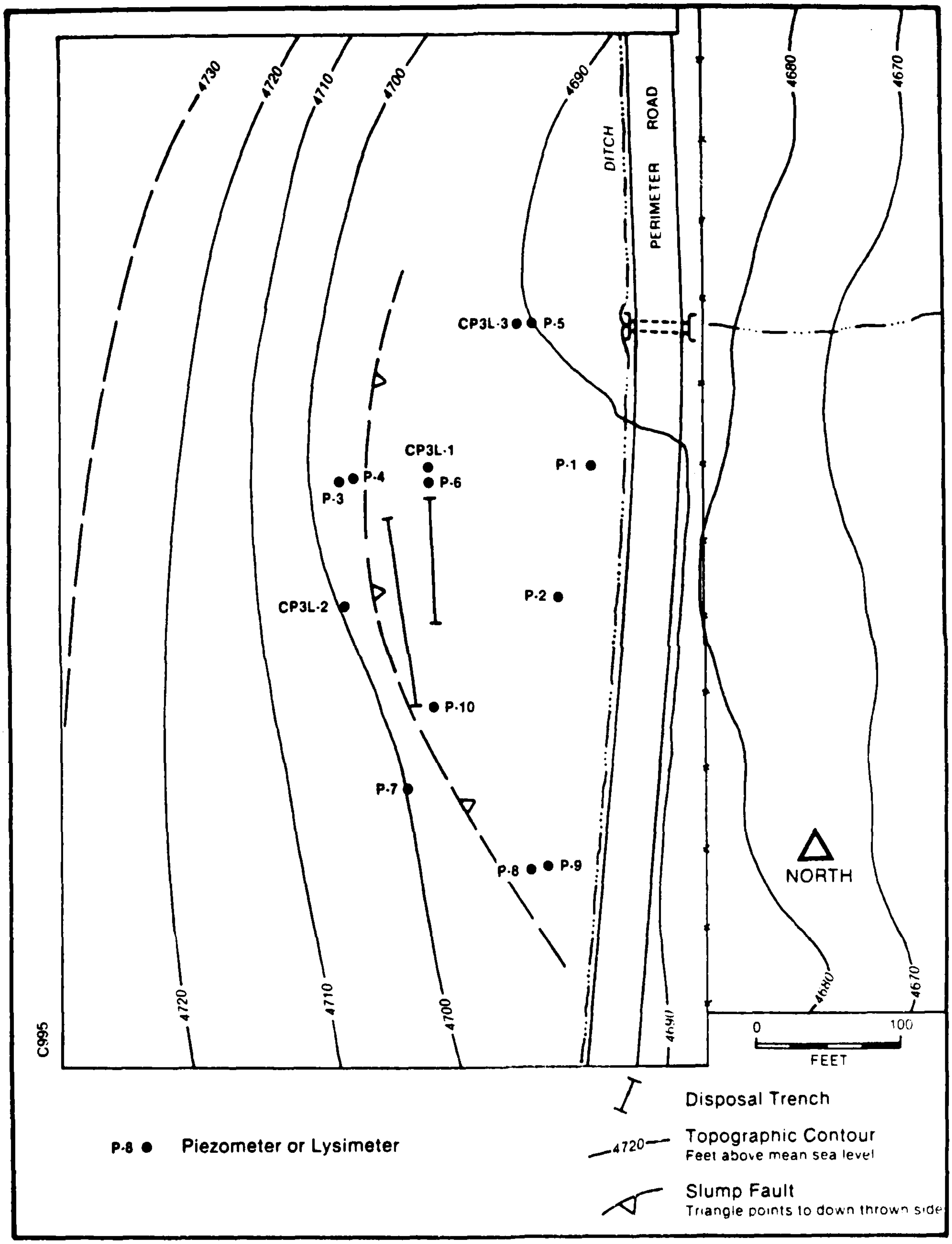

Figure 2-26. Piezometer and Lysime'er Locations, Chemical Disposal Pit No. 3.

3.0 FIELD PROGRAM

The need for a field investigation was presented in the IRP Phase I Records Search (Engineering-Science, 1982). In that investigation, thirteen waste sites were evaluated for their potential to contaminate groundwater systems. Eight sites were recommended for further consideration. The Air Force selected the four highest priority waste sites to be investigated under the initial IRP Phase II Field Investigation.

A field program was developed to evaluate the four waste sites. The program was designed to be flexible in order to permit tailoring the investigation as new information developed. The field activities commenced in mid-October 1982 and ended in late July 1983.

3.1 Development of Field Program

Two preliminary activities were carried out to develop the information needed to design the field program. First, a review of all available data was used to identify study needs and field procedures. Second, based on this data review, a safety program was developed to ensure adequate protection of the health and safety of all field personnel. In addition, the proposed geophysics program was modified as a result of the information gained from the data review.

3.1.1 Data Review

The nature of any hazardous waste site field investigation can be greatly influenced by the amount of data available about the site. The data review defines the field program direction and also reduces duplication of previous efforts.

The data review for this study consisted primarily of a review of available Hill AFB records. The data review was conducted to supplement the information in previous Air Force reports; such as the IRP Phase I Records Search, which were primarily summaries of the available data.

Data gaps which were identified were filled by obtaining additional records and conducting interviews with Hill AFB personnel concerning past activities at the disposal sites. Sources of additional records were the ESL Division of the University of Utah Research Institute, the Utah Geological Association, the U.S. Army Corps of Engineers, U.S. Geological Survey, the Utah Water Resources Agency, the Hill AFB Bioenvironmental Engineer's office, and the Hill AFB Civil Engineer's office.

The data review provided the information which allowed tailoring the field work to meet the program objectives more effectively. The following are some highlights of how the data review allowed tailoring the field program:

- Appropriate safety precautions were taken at each site;
- Drill cuttings were wrapped in plastic sheets and groundwater was contained in drums to minimize the chance of ground and personnel contamination;
- The number of monitor wells in the areas of Landfill No. 3 and and Chemical Disposal Pit No. 3 was decreased from 12 to 10;
- The boundaries of Berman Pond, Chemical Disposal Pits No. 1, 2, and 3 were more accurately located, thereby reducing the need for initial soil samplings for site delineation;
- An upgradient well was constructed. A resistivity survey was conducted on the base golf course for groundwater verification and recharge determination to the Landfill No. 3 and Chemical Disposal Pits No. 1 and 2; and
- The history of Berman Pond activities was developed to better assess its potential for environmental impact.

The various data review summaries (34 total) are provided in Appendix K of this report.

3.1.2 Safety Program

Prior to initiation of field activities, available information was reviewed to assess the potential for exposure to toxic and/or hazardous materials during the resistivity surveys, monitor well installation, soil coring, and sampling activities. Based on the information available from the pre-survey report, it appeared that exposures were possible although most of the contemplated field activities were outside waste disposal areas. Use of appropriate measures to protect employee safety and health in the field received high priority.

A comprehensive plan for the protection of employees during all phases of the Phase II field work was prepared with particular emphasis on any ground-disturbance activities. The plan was based on the work to be performed, the known and potential hazards which could be encountered, and accepted safety and industrial hygiene practice. It included graduated protective measures based on the potential for and expected severity of exposures which could accompany specific activities at specific locations. The plan also included provisions for handling a variety of less likely circumstances which could be encountered. The field safety plan was designed to be modified as improved information was developed or made available during work performance.

The safety plan was reviewed by Hill AFB safety personnel to ensure conformance with all applicable Base safety requirements. The Safety Plan is presented in Appendix L.

3.1.3 Personal Protective Clothing and Equipment

The nature of the work to be performed, exploration and equipment to be used, and potential hazards present at the site dictated the use of a variety of personal protective clothing and equipment. The type and extent of hazards likely to be encountered and, thus, the degree of protection required were anticipated to vary with work activity. In general, those activities which exposed or disturbed materials in the disposal sites or in close proximity to these sites were regarded as most

hazardous with the anticipated hazard decreasing with distance from the sites.

Well installation, core sampling, and well development within or in close proximity to the disposal sites were expected to pose the most significant potential hazards to the field team. Since the type and quantity of airborne contaminants to be encountered were unknown, respiratory protection (cartridge respirators) was required during specific operations. Impervious full body coverage was required during well drilling, sampling, and well development.

Resistivity surveying and groundwater sampling within the study areas were considered to be the least hazardous work category. Therefore, only minimal protection was specified.

Work performed in areas remote from known disposal areas was considered to present a low hazard. However, a minimal level of personal protective equipment was specified and, based on information developed during field activities, more protective equipment was used during augering or drilling operations.

All field personnel involved with ground disturbance or water sampling activities were briefed as necessary by Radian Corporation personnel on field safety procedures and requirements, including participants from UBTL, Construction Drilling International, the Hill AFB Bioenvironmental Engineer's and Civil Engineer's offices, and Earth Exploration and Drilling.

3.1.4 Development of Geophysics Program

As a result of the Phase I Record Search, Hill AFB, (Engineering-Science, 1982) electrical resistivity surveys were recommended to determine the lateral extent and thickness of clay lenses, and the lateral extent of any contamination plumes at Chemical Disposal Pit No. 1 and No. 2 and at Landfill No. 3. Subsequent discussions with Hill AFB engineering personnel at the presurvey meeting indicated considerable uncertainty as to the extent of contaminant migration as well as the depth and configuration of clay layers at Berman Pond and Chemical Disposal Pit No. 3. The proposed resistivity program provided for dipole-dipole

resistivity profiles at all sites and Schlumberger array soundings at Berman Pond and Chemical Disposal Pit No. 3.

After reviewing the Phase I recommendations an expanded records search was undertaken at Hill AFB which further assisted in delineating the Chemical Pit No. 3 and Berman Pond study areas. All disposal sites were inspected in the field and existing wells were identified by Hill AFB engineering personnel. The locations of grounded electrical structures (metal fences, power lines, buried pipes, etc.) were noted on maps prior to the survey design. The presence of fences and power lines, roads and paved parking areas made it impractical to undertake Schlumberger array soundings at Berman Pond and Chemical Disposal Pit No. 3. It was decided to complete the electrical resistivity survey for all areas using the dipole-dipole array with an electrode separation of 30 feet, as proposed for Chemical Disposal Pits No. 1 and No. 2 and Landfill No. 3. Survey lines were located to minimize electrical interference from fences, power lines and pipelines, to adequately cover each area, and to minimize interference with ongoing base activities.

As a further result of the expanded records search and observations made during the initial resistivity field work it became apparent that metal barrels, trash, and reinforced concrete had been deposited at Berman Pond, Chemical Disposal Pits No. 1 & 2 and Landfill No. 3. This gave promise of better defining the disposal areas with ground magnetic survey profiles. In addition ESL/UURI geophysicists determined that self-potential surveys offered some possibility of delineating the chemical pits and/or migrating fluids. A no cost contract modification was proposed and approved to: complete ground magnetic traverses at Chemical Disposal Pits No. 1 & 2, Landfill No. 3, and at Berman Pond; complete trial self-potential traverses at Chemical Disposal Pits No. 1 & 2 and No. 3; and, finally, delete Schlumberger array soundings at Chemical Disposal Pit No. 3 and at Berman Pond.

3.2 Implementation of Field Program

Five categories of field efforts were implemented and conducted for the IRP Phase II Field Investigation. They were:

- Geophysical Surveys;
- Soil Coring;
- Installation of Wells, Lysimeters, and Piezometers;
- Water Sampling (two episodes); and
- Areal and Elevation Survey

These efforts are described in the following sections.

3.2.1 Implementation of Geophysical Surveys

3.2.1.1 Electrical Resistivity Surveys. The electrical resistivity geophysical method is used to measure the earth's resistivity, i.e. the ease with which the ground conducts electricity. High resistivity values indicate poor conductivity whereas low resistivity values indicate good conductivity. In the earth electricity flows in ground water because of the movement of dissolved chemical ions (salts). Soil moisture is held both in pore spaces between mineral grains and within and adjacent to clay minerals; thus parameters that can cause changes in measured resistivity include:

1. Porosity and permeability of the ground
2. Amount of water in the ground (percentage of saturation)
3. Amount and type of dissolved salt
4. Amount and nature of other fluids in the ground
5. Amount and nature of clay minerals present.

Contaminated ground water usually has a higher concentration of dissolved chemical constituents than normal ground water and thus causes a lower earth resistivity. Liquid hydrocarbons, however, can increase the earth's resistivity because they are usually poor conductors themselves. Clay layers in the earth can often be detected and mapped by the low resistivity values associated with them. Such clay layers can impede flow of contaminant in the ground and it is therefore important to map them.

Earth resistivity changes caused by contaminants and clays are mapped at the surface by deploying a system of four electrodes. A precisely

controlled current is injected in the ground between two current electrodes. A resulting voltage is measured between the two potential electrodes. The measured voltage is a function of the geometrical parameters of the electrode array, the injected currents and the resistivity structure of the surrounding earth. The resulting apparent electrical resistivity can be calculated by

$$\rho_a = \frac{\Delta V}{I} \times Q,$$

where I = current introduced, ΔV = measured voltage, and Q is the geometric array factor. These measurements are taken at a number of points at the surface of the earth. Computer assisted interpretation of the set of resistivity data is then undertaken to construct a picture of the subsurface that reflects variations in clay content, fluid salinity and rock types.

Field Procedure. The electrode arrangement (array) used at all sites was the dipole-dipole array with an electrode separation (a) of 30 feet. Seven current electrodes (metal stakes) were driven in the ground, 30 feet apart, in a straight line. A current transmitter was placed at the center current electrode and wires pulled out to, and hooked up at each current electrode so that current could be transmitted through each pair of electrodes in sequence. One technician operated the transmitter while the geophysicist and another technician recorded voltage measurements observed with a receiver (digital voltmeter) for each potential electrode separation along the line. The seven current electrode array is commonly referred to as a seven-spread. It was necessary to redeploy the current electrodes and transmitter to a new "center" every 9a (270 feet) along the line to assure continuous data coverage.

Electrical resistivity measurement began at Chemical Disposal Pit No. 3 on 25 October 1982, then proceeded to the Berman Pond, Chemical Disposal Pits No. 1 & 2, and Landfill No. 3 areas in sequence.

3.2.1.2 Ground Magnetic Surveys. The earth's normal magnetic field is locally perturbed by the presence of various rock types and metal objects which contain the element iron. Metal objects such as barrels, wheels, and structural iron generally give rise to large (i.e. 100 gamma) anomalies when they are within 10-20 feet of a sensitive magnetometer. Because of the earth's magnetic field inclination (approximately 65° down to the north in Utah) the typical anomaly response is a magnetic low just north of the disturbing body and a sharp high over and south of the body. The typical response of a buried assemblage of metal waste material, is an erratic series of highs and lows as observed along the profiles.

Field Procedure. The ground magnetic survey was conducted along the resistivity profiles which had been measured and flagged in an earlier phase of the geophysical work. The survey crew included a geophysicist who directed the work and recorded data, and a technician who operated the proton magnetometer and helped maintain a constant separation using a measured length of wire. The magnetic field was sampled at a 10 foot interval until large variations in magnetic readings indicated the presence of metal dump material. The separation was then reduced to five feet.

Ground magnetic surveys were completed at Berman Pond, Chemical Pits No. 1 and No. 2, and Landfill No. 3 between 26 January and 2 Feburary 1983.

3.2.1.3 Self-potential Surveys. The self-potential (SP) method measures an electrical voltage difference at the surface of the earth which results from natural (rather than induced) electrical currents. The method has been employed since 1830 to search for buried mineral deposits which may generate electric currents through chemical reactions occuring near the water table. Electrical currents are also generated by groundwaters moving down gradient or by thermal fluids moving to the surface in fracture zones. Voltage differences of more than 1000 millivolts (mv) in a distance of one mile have been observed, and differences of 100 mv in 1000 feet are fairly common. It has been observed that metal trash undergoing oxidation and chemical reactions between industrial waste fluids and natural earth and ground water also give rise to local electrical currents.

Self-potential surveys were thus completed at Chemical Pits No. 1 and No. 2, and No. 3 to determine if this would be an effective mapping technique at Hill AFB.

Field Procedure. The self-potential traverses were conducted along the resistivity lines which had been completed earlier. Two nonpolarizing porous pot electrodes were employed to determine the voltage difference at the surface. One electrode remained fixed at a base station or reference point while the other electrode was advanced at 10 foot intervals. The voltage difference was measured with a Fluke digital multimeter. Self-potential measurements began at Chemical Disposal Pits No. 1 & 2 in mid-January and were completed by mid-February after several interruptions for severe winter weather. A two man field crew was required to complete this work.

3.2.2. Soil Coring

The purpose of the soil coring program was:

- To aid in identifying the precise locations and geology of Chemical Disposal Pits No. 1 & 2, Berman Pond and Chemical Disposal Pit No. 3;

- To obtain samples for selected chemical analyses to aid in verifying the site location and provide indications of waste characteristics; and

- To emplace lysimeters in selected coreholes for obtaining soil water samples.

A total of 95 soil and/or waste samples were taken during the soil coring activities, as follows:

- Berman Pond (24);

- Chemical Disposal Pits No. 1 & 2 (29), and 3 (35), with some at Landfill No. 3 (6) along with 1 quality control sample.

3.2.2.1 Reconnaissance and Confirmation Soil Corings. Reconnaissance soil corings were conducted early in the field program after an initial data review. The corings were taken with a hand auger by Radian and UBTL personnel using personnel protective gear. These soil corings, up to a depth of 5 feet, were used to provide confirmation of waste site locations, determine coring problems, identify field safety requirements for drilling and tailor the final confirmation soil coring program. Hand augering was very difficult at all sites due to gravels and cobbles.

The confirmation soil corings were conducted after additional data review in order to confirm the lateral extent of the site at Chemical Disposal Pits No. 1 & 2, and 3. The corings were also used to emplace lysimeters at Berman Pond and Chemical Disposal Pit No. 3, as well as to obtain samples for chemical analyses. The confirmation soil corings were conducted utilizing hand augers and/or a hollow-stem auger rig provided by Earth Exploration and Drilling of Bountiful, Utah. The corings ranged in depth from a few feet to about 15 feet.

3.2.3 Installation of Wells and Lysimeters

The installation of wells, lysimters and piezometers was accomplished by two drillings methods. The monitor wells were emplaced by the air rotary/casing drive method while the lysimeters and piezometers were installed by hand and/or hollow-stem augering. A total of 11 six-inch monitor wells were emplaced at the waste sites under study. A total of seven lysimeters were emplaced at Berman Pond (4) and Chemical Disposal Pit No. 3 (3); ten piezometers were emplaced at Chemical Disposal Pit No. 3. These activities were conducted from mid-November 1982 to February 1983. Monitor well construction delays were experienced due to extreme winter snows and temperatures. Out of approximately 24 potential drilling days, 11 days were called due to weather (7) and related construction problems (4).

3.2.3.1 Monitor Well Installation. Construction Drilling International (CDI) of Salt Lake City, Utah conducted the installation of

the 11 shallow and deep monitor wells at Hill AFB under the field supervision of the Radian hydrogeological project director. For the emplacement of the 6-inch wells, CDI utilized an air rotary/casing drive method. The completed monitor wells ranged in depth from about 14 to 113 feet. The well construction data summaries are located in Appendix C.

Of the thirteen monitor well locations initially selected, three wells in the areas of Chemical Disposal Pits No. 1 & 2, Landfill No. 3, and Chemical Disposal Pit No. 3 were dropped based upon results from the data review. One well was added at the Golf Course to investigate the groundwater recharge potential.

The data review and initial soil corings indicated that the well drilling might encounter contaminated soil or groundwater zones. Therefore, the minimum field apparel was changed to include protective slicker suits, gloves, boots, half-face respirators and chemical goggles. The specific items used were tailored to the field conditions and proximity to the waste sites. Later chemical analyses indicated that some contaminated soils and groundwater had been encountered, even though this was not obvious at the time of drilling.

To minimize the spreading of potentially contaminated soil, the air rotary drilling cuttings were collected on plastic ground sheeting. The cuttings were covered with plastic sheeting until sample analysis indicated final disposal requirements. Recommendation for final disposal of any contaminated cuttings were made to Hill AFB personnel.

3.2.3.2 Monitor Well Design. The initial well design was a 6-inch casing driven during drilling to a specified depth as determined by the field hydrogeologist. A 5-foot long, 5-inch diameter stainless steel screen was to be emplaced in the casing to total depth and the 6-inch casing pulled to expose the screen. Based upon the initial site visits, data review, soil corings and discussions with Base personnel, it was determined that the proposed monitor wells could encounter contaminated soils and/or shallow groundwater. In order to insure that the prospective deep monitor wells would not become contaminated internally as the drilling proceeded or possibly open lower formations to contamination, the

drilling procedure was modified. For the prospective deep monitor wells at Landfill No. 3, Chemical Disposal Pits No. 1 & 2, and Berman Pond, an 8-inch casing was first drilled and driven into the underlying clay as practical. This served as a surface casing and permitted inserting of the 6-inch casing down to the clay, blocking off and by-passing any possible contaminated zone. Normal drilling was then continued. This procedure prevented introduction of contamination from inside the 6-inch casing into a clean aquifer and better insured that water samples would not be affected by contaminated well materials.

Well construction materials were changed at three monitor wells (M-7, M-9, and M-3) which were completed using plastic casing screen and bottom plugs through the 6-inch casing instead of the proposed stainless steel screen. During drilling of the first two wells (M-7 and M-9) the underlying clay encountered was much shallower than anticipated and there was no direct evidence of groundwater. Rather than use an expensive well screen in a potentially dry hole, plastic casing and screen were used, saving the stainless steel screens for more appropriate applications. For the third well (M-3), the artesian aquifer under the clay where water was encountered could not be distinctly identified. Therefore, slotted plastic casing was used to screen a larger interval than the 5-foot stainless steel screen. This was to ensure open screen across any water-bearing zones.

Heaving sands and silts in monitor well GC-1 precluded the proper emplacement of the stainless steel screen. Therefore, the bottom of the 6-inch casing was driven to total depth and left open to the formation.

3.2.3.3 Lysimeter Installation. In order to characterize the potential for continued mobilization of contaminants from soils around and/or underlying the waste sites at Berman Pond and Chemical Disposal Pit No. 3, a total of 7 lysimeters were emplaced about these sites. Four lysimeters were installed at Berman Pond and three at Chemical Disposal Pit No. 3. Lysimeters were used to collect samples of water in the vadose zone to determine if leaching of contaminated soils underlying the sites is occurring. When a vacuum is induced on these instruments, a sample is collected from a specific depth using a several-inch porous ceramic cup.

Chemical analyses of water collected, coupled with data on subsurface geology, allowed assessment of the potential for further groundwater contamination and off-base effects.

The lysimeter depths at Berman Pond ranged from 12.5 to 14.5 feet; geologic materials were uniformly sands. At Chemical Disposal Pit No. 3 the lysimeters were placed at three different levels because of the geologic complexity of the site (i.e., sand/gravels at several horizons). These depths were 2.5, 10.0, and 17.5 feet.

The lysimeters were hand-emplaced using hand and hollow-stem augers. Soil water samples were collected from the lysimeters during two sampling episodes. Out of 14 possible lysimeter samples to be collected, approximately 9 were successful. The other samples could not be collected because no water was produced. These failures to collect samples can be attributed to insufficient soil moisture, lysimeter leak(s) and low winter temperatures which caused freezing of one piezometer.

3.2.3.4 Piezometer Installation. The electrical resistivity survey and subsequent field observations indicated that Chemical Disposal Pit No. 3 was situated on a geologically complex slump feature. Rather than emplace a single relatively expensive monitor well into this complex zone, it was recommended that several inexpensive piezometers be emplaced to investigate and define site conditions.

Ten shallow piezometers were emplaced at Chemical Disposal Pit No. 3, ranging in depth from 7 to 50 feet. The 2-inch diameter PVC piezometers were emplaced using solid and/or hollow stem augers and grav l packed. These piezometers were designed not only to provide information on groundwater levels but also to provide groundwater sampling locations. The piezometers were emplaced in two episodes.

The first five piezometers were emplaced from January 6 to 13, 1983, to define the site geologically. The lithology and depths to groundwater changed greatly over small distances (i.e., tens of feet) confirming the resistivity interpretation that the site was very complex geologically.

Installation of an additional set of piezometers to further define the site was recommended to and approved by the Air Force. Installation took place from January 25 to 31, 1983.

The second set of piezometers again confirmed the complexity of the site -- both geologically and hydrologically. Groundwater in two piezometers (P-6 and P-7) had strong "solvent" odors not encountered in the first set of piezometers. The total area covered by all ten piezometers was about 330 feet by 160 feet. Depths to groundwater below ground level ranged from 10 to 25 feet, and the piezometer zones of completion were in clays or sand/gravel materials.

Piezometer installation problems were encountered during both phases. These were due to water sands collapsing the hole and/or sticking the bit, clay slowing the augering, and piezometer casing breaking off below ground level. All problems were overcome without adversely affecting the completion times or budget. The resulting piezometer construction data are summarized in Appendix C.

3.2.4 Water Sampling

Shortly after the completion of the 28 monitor wells, lysimeters and piezometers, an initial water sampling was conducted to collect samples for chemical analysis. The initial sampling ended in February 1983. The purpose of the chemical analysis was to establish the present groundwater quality and to determine the impacts, if any, from the waste sites. GC/MS and ICP screening analyses were performed on selected samples to determine if contaminants were present which had not been noted in the disposal records. Additional analyses were recommended for the second round of sampling.

The second round of sampling was performed in late April and May 1983. The purpose of the second round of sampling was to collect water samples after the main winter precipitation events and spring snow melts to assess the potential for contaminant/migration as a result of precipitation or run on passing through the waste sites. Additionally, the second round of sampling provided an analytical comparison with the initial round of sampling.

3.2.4.1 Monitor Well and Piezometer Sampling. Monitor wells and piezometers were sampled after development by bailing had been conducted. In general, all of the wells and piezometers constructed under

this program were found to be very low producers. Based on the low production of the wells and piezometers and after coordination with the U.S. Air Force Project Monitor, it was agreed that withdrawal of 3 well volumes prior to sampling was sufficient to ensure that formation water was sampled and to minimize suspended sediment that would result from development in the fine sand and silt water bearing zones. Because only about half well volumes were withdrawn at any one bailing time development of the wells and piezometers generally occurred over a period of days to reach the 3 volume target. A summary of development results are contained in the monitor well and piezometer completion logs in Appendix C. Section 3.4 provides an overview of the field sampling procedures.

Throughout monitor well and piezometer development protective clothing was worn, including slicker suits, rubber boots, protective gloves and splash goggles. The discharge water was placed into 55 gallon drums provided by the U.S. Air force to prevent infiltration of potentially contaminated water. The drums remained at each well or piezometer location until chemical analyses were completed so that recommendations for final disposition could be determined. The bailers were rinsed between wells and piezometers using distilled water and/or Base potable water. A rinse of methanol and distilled water was performed on bailers used to sample piezometers at Chemical Disposal Pit No. 3 where solvents were detected.

3.2.4.2 Lysimeter Sampling. During lysimeter sampling it was found that, due to the small water volumes produced, it was necessary to collect samples over a period of days. In some cases this required compositing samples in order to obtain the required volumes for chemical analysis of all parameters. Several different sample containers and a priority order for filling the containers were established in the event that sufficient water could not be collected. Personnel from the Base Bioenvironmental Engineer's office assisted in this task, after receiving field instruction and sampling priority instructions.

General problems that were encountered with the lysimeters during the field program included: maintaining suction (3) on the lysimeter possibly due to leakage, freezing (1) and low moisture capture (2). Overall,

better soil moisture collection occurred after the spring thaw period during the second sampling episode. Section 3.4 provides an overview of sampling procedures.

3.2.5 Aerial and Topographic Control

Accurate three dimensional reference controls are especially critical when examining groundwater and/or contaminant flow directions. After completion of the installation of wells and piezometers, all necessary vertical and horizontal control points, which included elevations and selected locations were identified. The vertical control was to 0.01 feet for the monitor wells and piezometers while ground control was to 0.1 feet. Horizontal control was at least to 0.1 feet. Surveying was conducted by personnel from the Hill AFB Civil Engineer's office.

3.2.5.1 Survey Control Point Identification. A survey control point inventory was conducted to provide personnel from the Hill AFB Civil Engineer's office the information required so that they could conduct their surveying. During the inventory, the wells, piezometers, lysimeters and selected ground level control points were identified by color coded flagging. Names and elevation reference points were marked on the well and piezometer casings. Based upon a recommendation during the field activities an expanded topographic survey was requested for the area downslope of Chemical Disposal Pit No. 3, as an aid in defining the slump feature at the pit. The Air Force survey team provided the control data and a topographic map of the site was constructed.

Additionally, previously installed monitor wells were selected for elevation control surveying because many had damaged surface casings. New sanitary caps were placed on the monitor wells after identification. The elevation data permitted the accurate use of groundwater and well measurements. The following summarizes the type and number of the elevation and/or location control points:

- 28 IRP Phase II monitor wells, lysimeter and piezometers,
- 40 existing monitor wells, and
- 221 ground level control points

3.2.5.2 Surveying. Hill AFB Civil Engineering survey personnel conducted the various surveying requirements after receiving on-site orientations by contractor personnel. No major surveying problems were encountered during the project. Several coordination discussions were held between contractor personnel and the Hill AFB surveying personnel in order to ensure appropriate grid "tie-in" controls. This coordination dealt with the data grids developed during the field investigation and the survey master control points used by the survey crew. The surveying and coordination were conducted periodically from May to late July 1983.

3.3 Field Instrumentation and Systems

3.3.1 Hydrogeological Equipment

Four basic field instruments were used during the hydrogeological field investigation. An electrical water level measuring line (Soil Test Model DR-772) was used for obtaining groundwater levels and selected monitor well and piezometer soundings. The accuracy of the measurements with the electric line has been ±0.01 feet. A 100-foot steel surveyors tape and "water chalk" was also periodically used to obtain static water levels to verify the electric line measurements. This was to ensure the electric lines' accuracy. The steel tape was also used for sounding the depths of the monitor wells and piezometers.

The next two field instruments were used primarily during monitor well/piezometer development and sampling. They were a field conductivity meter (Yellow Springs Instrument Model YSI 33SCT) and a pH meter (Cole Parmer Model 5982-20). These instruments provided a means to determine the relative groundwater quality during well development and sampling. The conductivity meter was further used to obtain in-situ groundwater temperatures and conductivity measurements. As a quality control measure, the laboratory provided a calibration test of the meter because of the harsh winter field conditions.

The pH meter was periodically checked against laboratory standard solutions to insure valid measurements. In addition, pH paper was used in the field to cross-check the meter for quality control.

3.3.2 Geophysical Survey Equipment

3.3.2.1 Electrical Resistivity Survey. Three different electrical resistivity instrument systems were used in the course of the Hill AFB survey. The initial high power generator-transmitter (Phoenix Inc.) system was transferred to another job requiring the added power. A second high power motor generator-transmitter (Elliot system) was used two days while the optimum signal enhanced battery powered Bison system was en route to the field site. The equipment use by site is indicated below. A brief description of each system follows.

Equipment Use by Site

Chemical Disposal Pits No. 1 and 2, Lines 1-6	Bison 2390 system
Landfill No. 3, Lines 1-5	Bison 2390 system
Golf Course Area, Lines 1 and 2	Bison 2390 system
Berman Pond, Line 1	Elliot 15A Tx; Fluke Rc.
Berman Pond, Lines 2-4	Bison 2390 system
Chemical Disposal Pit No. 3, Lines 1, 2	Phoenix 10A Tx; Fluke Rc.
Chemical Disposal Pit No. 3, Lines 3, 4	Elliot 15A Tx; Fluke Rc.
Chemical Disposal Pit No. 3, Line 5	Bison 2390 system

Phoenix Geophysics Limited System. A model MG-2 motor generator is driven by a 4-cycle Briggs and Stratton motor which produces 5 HP at 3600 rpm. The generator is rated at 2000 volts-amperes suitable for exploration to depths exceeding 2000 feet. The generator provided current to a model IPT-1 variable frequency and time domain resistivity/IP current transmitter. The current transmitted could be varied in six steps from 3mA to 10A, with output voltage ranges at 75 v, 150 v, 300 v, 600 v and 1200 v. The change in output current is less than 0.2% for a 10% change in input voltage or electrode impedance, and can be monitored at all times. The receiver used with the Phoenix transmitter was a standard Fluke 8050 A Digital Multimeter, with a measurement range between 10 microvolts and greater than 100 volts.

Elliot Resistivity System. (Leased from Melano-Pyxis, Inc., Bountiful, Utah). The Elliot Model P-15B engine-generator is driven by a

Tecumseh engine and develops 120 volt 400 Hz current at 1800 vA. The Elliot Model 15A time domain IP transmitter features all solid state circuitry and produces 1500 watts. The output voltage can be varied from 200 to 3000 volts in 12 switch selected steps. The current can be varied to a maximum of 5 amps. The Fluke 8050 Digital Multimeter (described above) was used as a receiver with this transmitter.

Bison Instruments, Inc. 2390 Resistivity System. The Bison Model 2390-T-50 transmitter is a low power (max 50 watts) battery driven transmitter with selectable current output at 10 mA, 20 mA, 50 mA and 100 mA, and a voltage output of 0 to 50 v. Eight operating frequencies are available from 0.1 to 5 Hz. The model 2390-R receiver is a synchronous detection instrument which stacks and averages 10 cycles and continuously displays this average. The fine receiver capability offset generally low noise levels such that the 10 to 100 mA current range was more than adequate for the Hill AFB surveys. The rechargeable battery transmitter power supply proved more convenient than the higher power gasoline fueled motor generator.

3.3.2.2 Magnetometer Instrumentation. A GSM-8 proton magnetometer was leased from Great Basin Geoservice, Salt Lake City, Utah. The magnetometer is a lightweight battery powered one gamma proton precession magnetometer with liquid crystal display. The instrument is manufactured by GEM Systems, Inc., Toronto.

3.3.2.3 Self-potential Instrumentation. The self-potential survey was conducted with two pairs of Tinker-Razor ceramic porous pot electrodes, 1000 feet of lightweight field communication wire, and a Fluke 8050 A Digital Multimeter (described earlier).

3.4 Sampling Procedures, Sample Preservation and Data Reduction

3.4.1 Soil and Water Sampling and Preservation

Soil samples were collected in wide mouth jars with Teflon-lined lids which were cleaned and provided by the laboratory.

Groundwater samples were collected after development from each monitor well and piezometer emplaced during this investigation in addition

to selected previous monitor wells. The samples were collected with a PVC bailer and then poured directly into an appropriate sampling container provided by the laboratory. In some cases, due to small sample retrieval or a small sample container the bailed sample was first placed into a clean inert beaker. This permitted the collection of enough sample, reduced spillage and allowed for the careful placement of the water sample into a small container. The laboratory provided all sample containers with appropriate preservation material in the containers.

Samples from the lysimeters were generally easier to collect than samples from the monitor wells and piezometers. This was because in all cases the small volumes of soil moisture collected could be placed directly into the sample containers without any intermediate containers. This cut "double handling" thereby reducing the chance of outside contamination. When the lysimeter samples were collected the same preservation procedures and storage techniques were used as for the groundwater samples. All samples were either maintained in an ice chest on "blue ice" or temporarily stored in a refrigerator at the Hill AFB Bioenvironmental Engineer's office. While the samples were in the field or in transit they were kept in an ice chest with "blue ice.".

In most cases the sample collection was conducted jointly by a field geologist and a laboratory representative who then took the sample back to Salt Lake City for processing at the laboratory. In some instances, especially during compositing of samples, the samples were not taken directly back to the laboratory. These samples were temporarily stored in a refrigerator at the Bioenvironmental Engineer's office for collection, and eventual pick-up. A chain of custody form was principally used at this time for transferring custody of samples from the Bioenvironmental Engineer's office to UBTL. The chain of custody forms are provided in Appendix E.

3.4.2 Geophysical Sampling Procedures and Data Reduction

3.4.2.1 Electrical Resistivity Surveys. Every electrical resistivity measurement required the recording of three parameters in the field: the current transmitted (I, in amps or milliamps), the voltage

measured (v, in millivolts), and the electrode separation (n) which determines the geometric array factor. Additional comments recorded related to the location of roads, fences, power lines and other cultural features to insure proper location of lines on base maps, and to assist in interpretation. The current transmitted rarely changed during a given observation, and was recorded by the transmitter operator. The operator noted which electrodes were being transmitted, current, and any change in current. The receiver operator recorded the receiving electrodes, the separation (n), and the observed voltage. The Bison resistivity receiver automatically stacked, averaged and displayed the average of 10 voltage values; two to four averaged values were recorded by the receiver operator. The Fluke 8050 Digital Multimeter, used with the Phoenix and Elliot transmitters, did not stack and average but was continously monitored by the operator for several (3-10) transmitted cycles. The operator would record only 2-4 representative voltage values since the current could always be increased to improve the signal-to-noise level.

The data were reduced according to the expression

$$\rho_a(\text{ohm-m}) = \frac{\Delta V}{I} \cdot Q \cdot a \quad ,$$

where $Q = 2\pi ck$
$c = 0.3048$ m/ft
k = geometric factor = $\dfrac{(n)\ (n+1)\ (n+2)}{2}$
$a = 30$ ft.

The resistivity values were then plotted on pseudosection plots (Appendix G). Geophysical plotting convention requires plotting the reduced resistivity values at the intersection of lines drawn (at 45° to the horizontal) from the midpoints of the transmitting electrodes and the receiving electrodes. Subsequent interpretation for selected profiles included iterative numerical modeling on a Prime 400 computer to determine which resistivity distribution best explained the observed data.

3.4.2.2 Ground Magnetic Surveys. The GSM-8 proton magnetometer directly outputs the value of the earth's magnetic field in gammas (nanoteslas). Standard field procedure requires reoccupying a base station for each survey site at intervals of one hour or less, so that the diurnal variation of the earth's field may be determined. The diurnal

change (generally less than 10 gammas) was then linearly extrapolated between reoccupation times and a correction applied to all observed data so that the corrected data values are referenced to a single time and magnetic field value. The data values were plotted and contoured in map form (Appendix G).

3.4.2.3 Self-potential Surveys. The self-potential survey was conducted with a stationary reference electrode and advancing the lead electrode after each reading. After placing the lead electrode in the soil, voltages often varied for one half to three minutes before stabilizing. The period of stabilization was monitored with the Fluke Digital Multimeter, and voltage values recorded when stabilization appeared adequate. A continuing drift of voltage values was observed at some stations, and the operator had to exercise his judgment how long to continue the observation. If a survey line was extended, the new base station value was adjusted to the primary base station. The reduced data values were plotted on a map and contoured.

3.5 Reliability of Sampling Program

3.5.1 Hydrogeological Field Sampling Reliability

In addition to the precautions noted in Section 3.3, a number of procedures were implemented during the field sampling activities in order to reduce the chances of sample contamination, or cross-contamination.

All monitor wells and piezometers were ordered and prioritized for development and sampling. The general priorities establishd were upgradient before downgradient, deep before shallow, and least suspected contamination zones before most contamination zones about the disposal sites.

Three different bailing ropes were used. One rope each was solely dedicated to specific type sampling points or a disposal site to reduce the possibility of cross-contamination. There was one rope for only the Berman Pond monitor wells, one for the shallow and another for the deep monitor wells at Chemical Disposal Pits Nos. 1 & 2 and Landfill No. 3 areas.

One bailer at Chemical Disposal Pit No 3 was dedicated to Piezometer P-6 during development. This was due to the great amount of solvents detected during the completion of the piezometer while the other piezometers appeared to have none or very little. Bailing activities at the other 2-inch piezometers were conducted with another separate bailer.

Sample handling in most cases was minimized by pouring directly from the bailer into the sample container. In some cases the sample had to be first collected in a clean beaker than transferred to the sample container.

It is felt that reasonable precautions were taken during the field activities to minimize the possibility of introducing contamination. A relative indication of the programs' success is provided by the chemical analyses for the lysimeters versus neighboring monitor wells or piezometers. In this case lysimeter sampling fluids went directly into the sample container without an intermediate handling as with a bailer. The results of the chemical analysis showed that when contamination was detected in a lysimeter similar contamination also was detected in neighboring monitor wells or piezometers.

3.5.2 Reliability of Geophysical Techniques

3.5.2.1 Electrical Resistivity Surveys. The precision of a given resistivity observation is estimated to be within one percent. Fluctuating noise levels, varying receiver separations (i.e. 29 feet instead of 30 feet) and varying electrode polarization tend to reduce the measurement accuracy below this level. Signal averaging and monitoring observed voltages over several current cycles tend to offset noise problems to some degree. Repeat measurements (when transmitting and receiving electrodes are reversed) should indicate the accuracy for a given measurement, if electrical reciprocity strictly applies. (Heterogeneous resistivity distribution with extreme local variations may result in different current densities for different receiving electrodes, so reciprocity may not always apply). Repeat measurements and occasional small errors in dipole lengths probably restrict the overall accuracy in apparent resistivity values to ± 8 percent, for resistivity values which

ranged from two to over 1000 ohm-m. Larger errors did result from out-of-syncronous signal detection (Bison system) but these errors were apparent in the data. Two lines were repeated to correct this problem.

The observational accuracy is considered insignificant in terms of resulting data interpretation and presentation, in part because of the multiplicity of data values obtained with the dipole-dipole method and in part because of the wide range of resistivity values observed (2-1000 ohm-m). The resistivity structure mapped by the method is adequately determined: to depths of twice the electrode separation, or 60 feet for Hill AFB surveys; for a width of one electrode separation either side of a line (i.e., 30 feet). The resistivity structure is not well defined for the last two electrode separations at each end of a given line.

3.5.2.2 <u>Ground Magnetic Surveys</u>. The reduced magnetic intensity value is generally accurate to ± 2 gammas at a given station when referenced to a given base station reference time. The error could result in nonlinear variation of the earth's magnetic field or transient cultural noise (power lines, etc.). This error amounts to 2/54,000 of the earth's magnetic field, or 2/600 of the largest observed anomalies (Berman Pond site), or 2/10 of typical background variation, and is considered insignificant in interpreting survey results. Although the survey line spacing is adequate for indicating the general shape and location of magnetic materials in dump sites, the magnetic field variation is of short wavelength for small, shallow objects so these have not been delineated in detail.

3.5.2.3 <u>Self-potential Surveys</u>. The instrumental precision of a surface voltage measurement is of the order of microvolts, very small compared to the reporting (rounded data) value of millivolts. The most significant error sources are fluctuating earth currents, both natural and manmade, and voltages resulting from nonequilibrium between the porous pot electrodes and the soil in which they are emplaced. The magnitude of errors, and effect on accuracy, from these sources is variable, and difficult to estimate. The instrument operator minimizes these errors by continuously monitoring the voltages on the digital multimeter and taking stable data values. The error between stations referenced to a common

base is estimated at ± 3 millivolts for 90% of the stations in a given survey. Since the method was used in qualitative "anomaly detection" mode, this accuracy is more than adequate. The separation of survey lines may have been too large to locate individual 50 gallon drums undergoing oxidation.

3.5.3 Reliability of Laboratory Analyses

A number of varied chemical analyses were performed in support of the Hill AFB Phase II Survey. Most of them were routine EPA procedures which have documented precision and accuracy criteria. The samples were stored under refrigeration or at room temperature, as required, before analysis. Overall, 5% of the samples processed were quality control samples prepared by the laboratory quality assurance group. Additionally, 10% of the samples were analyzed in duplicate. Analytical results were not released until cleared by the quality assurance group. In general the analytical results met accepted criteria for precision and accuracy. Unusual situations are discussed in the following paragraphs.

In the first round of sampling, there was some overlapping of data because of the GC/MS screening analyses which were performed. Some discrepancies in the overlapping analyses were observed. The colorimetric total phenol analysis (EPA 420.2) tended to give higher results than the total of the phenols determined by the GC/MS method (EPA 625). The colorimetric method is more susceptible to interferences than the GC/MS method. Thus, the colorimetric result should be regarded as an upper bound and the GC/MS result regarded as correct or possibly low.

The laboratory encountered instrument difficulty with the analysis for volatile aromatics (EPA 602). In the first round of sampling, the wells were resampled for the EPA 602 analysis. There was a discrepancy between the EPA 602 result for benzene from Well M-2 and the GC/MS result (EPA method 624) for the same sample. Part of the discrepancy may be attributed to the different sampling times. However, the higher EPA 602 result is probably due to an interference. Therefore, the EPA 602 result should be regarded as an upper bound.

Several discrepancies between the TOX data and results from analyses by EPA Method 601 for volatile halocarbons by GC or EPA Method 624 for volatile halocarbons by GC/MS were noted. In general, TOX data in water trend toward reporting low values for volatile organic halogens and high values in the presence of inorganic chloride. It is the opinion of the project team that the TOX method is the least reliable of the three. An analysis for all 29 parameters by EPA Method 601 was substituted for the TOX method in the second round of sampling.

The soil analyses were modifications of standard water analysis procedures. The modifications (described in Appendix E) produced results which were somewhat less reliable than the original water methods would have provided for water samples. However, the purpose of the soil analyses was to locate waste disposal areas; and they were sufficient for that. The least reliable was the determination of TOX in soil. It was thought to be of some value for comparisons within a site. The determination of TOX in soil was difficult to reproduce and the recoveries of the two compounds evaluated were low (53% for 2,4,6-trichlorophenol and 36% for trichloroethylene).

The TOX soil results were not corrected for recovery based upon this data in view of the following considerations:

1. Different compounds would be expected to exhibit different recoveries.
2. Soils from different sites would be expected to demonstrate different affinities for the compounds.

4.0 DISCUSSION OF RESULTS AND SIGNIFICANCE OF FINDINGS

4.1 Discussion of Results

4.1.1 Chemical Disposal Pits No. 1 & 2

4.1.1.1 Geophysics Results and Reliability. A total of six dipole-dipole lines were completed across the area in north-south and east-west directions using 30-foot dipole spacings. The line locations are shown in Figure G26 (Appendix G). The observed apparent resistivity data are presented as Figures G27 to G32.

4.1.1.1.1 Geophysical Results. Line 1 is an east-west line centered on previous well W-4. This well contains a film of oils and grease floating upon the water table. The apparent resistivity data (Figure G27) show a resistive surface layer that extends over most of the line. The apparent resistivities decrease with depth indicating the presence of an underlying layer that is likely to have a higher clay content. A change in topographic slope (down) occurs between stations 7E and 10E. As a result the deeper, less resistive, layer occurs at a shallower depth although it is the same stratigraphic unit.

Line 4 (Figure G30) is also centered on previous well W-4. This line trends north-south, however, and is normal to line 1. The observed resistivity data on line 4 show an increase in thickness of the resistive surface layer northward of the test well. The resistive surface layer is mainly sand and gravel with little clay, and would not be a barrier to the northward movement of the groundwater likely perched upon the underlying clay bearing layer.

Line 2 (Figure G28) is an east-west line roughly centered in the middle of Chemical Disposal Pit No. 2. This line also shows the presence of the resistive surface material above the more conductive deeper layer. The effects of an increase in topography between station 4W and 7W is truly depicted as an increase in the thickness of the surface layer. Small resistive zones are present in the pit area that are thought to relate to the hard residue encountered in digging the electrode holes. The underlying conductive layer is also present beneath the eastern

portion of the line. The modeled resistivity distribution shown in Figure G34 shows an irregular distribution of 50 to 1200 ohm-m zones overlying the conductive layer. The conductive layer has a higher resistivity (25 ohm-m vs 10 ohm-m) from 0 to 6 south. This may be the result of chemical residue extending downward into the conductive (clay rich) layer.

Line 3 (Figure G29) is also an east-west line and is centered approximately in the middle of Chemical Disposal Pit No. 1. This line is similar to Line 2. Small, near-surface, resistive zones occur near the assumed pit areas. A hard, compacted residue was encountered in digging the electrode holes and may partially cause these resistive zones.

Line 5 (Figure G31) is a north-south line centered in Chemical Disposal Pit #1 and passing through Pit #2 (Sta. 3N). The observed data show, in general, a resistive surface underlain by a much more conductive layer. At best, this line does indicate there is an apparent clay layer beneath the gravels occurring at the surface. The numerical model solution (Figure G36) indicates variable high resistivities (100 to 1200 ohm-m) overlying a 10 to 50 ohm-m clay layer 30 to 60 feet deep.

Line 6 (Figure G32) is similar to Line 5. The northern half of Line 6 crosses through a depression left after the removal of gravel, effectively placing the conductive clay layer closer to the surface. The higher apparent resistivities occurring near the surface on the southern end of the line are adjacent to the area thought to contain the disposal pits.

Four numerical models were computed for lines within the area of Chemical Disposal Pits No. 1 & 2. These models (Figures G33 to G36) while not being exact fits to the observed data, are nevertheless good representations of the ground conditions within the pit areas. They are particularly useful in obtaining approximate depths to the underlying clay layer represented by the lower resistivity values.

Figures G37 and G38 are constructed from the numerical models. These figures are maps of the intrinsic resistivity distribution for the depth intervals 18-30 feet and 45-60 feet. They show in plan view the extent of the resistive zones and the underlying conductive clay bearing areas. In

addition, the small resistivity anomalies within the pit areas are partially defined.

Ground Magnetic Survey. A limited ground magnetic survey was also completed in the area of disposal pits 1 and 2. These data, shown on Figure G39, were obtained from stations spaced at five foot intervals along resistivity lines 2, 3 and 5. There is some metal waste lying upon the surface in the pit areas. The ground magnetic survey has aided in delineating the outline of the pit areas where they were filled with dirt and trash containing iron objects. As shown on Figure G39 the magnetic variations occur over a large (150 by 300 ft) area which includes the two small pits. The variations in magnetic intensity result from metal waste or possibly from changes in magnetization of surface soils as a result of the high heat of the burning oils.

Self-Potential Survey. A self-potential (SP) survey was also conducted to further aid in evaluating Chemical Disposal Pits No. 1 & 2 (Figure G40). Topography is higher west and south of the pit area, hence the negative SP observed in these directions is probably related to water moving from higher to lower elevation. Water pools occur at the surface in the disposal pit area. Therefore, water could seep into the underlying sediments beneath the pits. Much of the observed SP variation occurs within two small areas associated with the disposal pits. Individual stations vary between a plus 62 millivolts and a minus 52 millivolts, but in general the area of the pits contains the more positive SP values. This indicates that electrochemical reactions due to chemical residues and fill material are still continuing within the soil.

4.1.1.1.2 Reliability of Geophysical Results. The numerical models shown for the electrical resistivity data were developed using a two-dimensional algorithm. While being non-unique they nevertheless produce calculated results that agree with the observed data for the most part to ± 10%. This is acceptable for the use of a two-dimensional algorithm to match data from a three-dimensional environment.

The ground magnetic data shown on Figure G39 are averages from two to five individual instrument readings taken at each station. These

individual readings vary from zero (0) in quiet areas to over 100 gammas near discarded iron trash.

The self-potential (SP) data are difficult to evaluate as individual stations. The data were obtained by monitoring the natural signal until stability was observed. The data were collected along traverses and each traverse was "closed" by reading the base station a second time. These closures repeated within 3.0 millivolts.

4.1.1.2 Field Investigation Results and Reliability.

4.1.1.2.1 Definition of Pit Locations. One of the purposes of this site investigation was to determine as accurately as possible the location of the Chemical Disposal Pits Nos. 1 & 2. Through the use of aerial photography, reconnaissance hand auger borings, soil sampling and analysis, and discussions with Base personnel (Keith Davis, 1982; Goodrich, 1982), the pits have been precisely located. The pits were not readily identifiable at the outset because they had been graded over upon closure.

The pit locations and configurations are shown on Figure 4-1. It should be noted that the pit configurations on Figure 4-1 are from 1971 aerial photgraphy and the extent and depths at the time of closure in 1973 are not known, although it appears reasonable that they were probably not significantly different from those in 1971. Figure 4-2 depicts the results of soil coring used to locate the pits. The figure shows the locations of hand augered samples in which obvious hydrocarbon waste material was found. Some difficulty was encountered in correlating the 1971 aerial photography with the field sampling results because several roads visible in the photographs obscure the reference points for auger locations. However, it is judged that the pits have been positively identified and located. No other pits are known to exist in this area.

4.1.1.2.2 Groundwater Impact. A primary objective of the study was to determine the existence or potential for impacts on the local groundwater regime downgradient of wells W-4 and 80-20 (Figure 2-22). Therefore, to determine this, monitor wells were emplaced about the waste sites and were used to obtain data on the groundwater system for both the

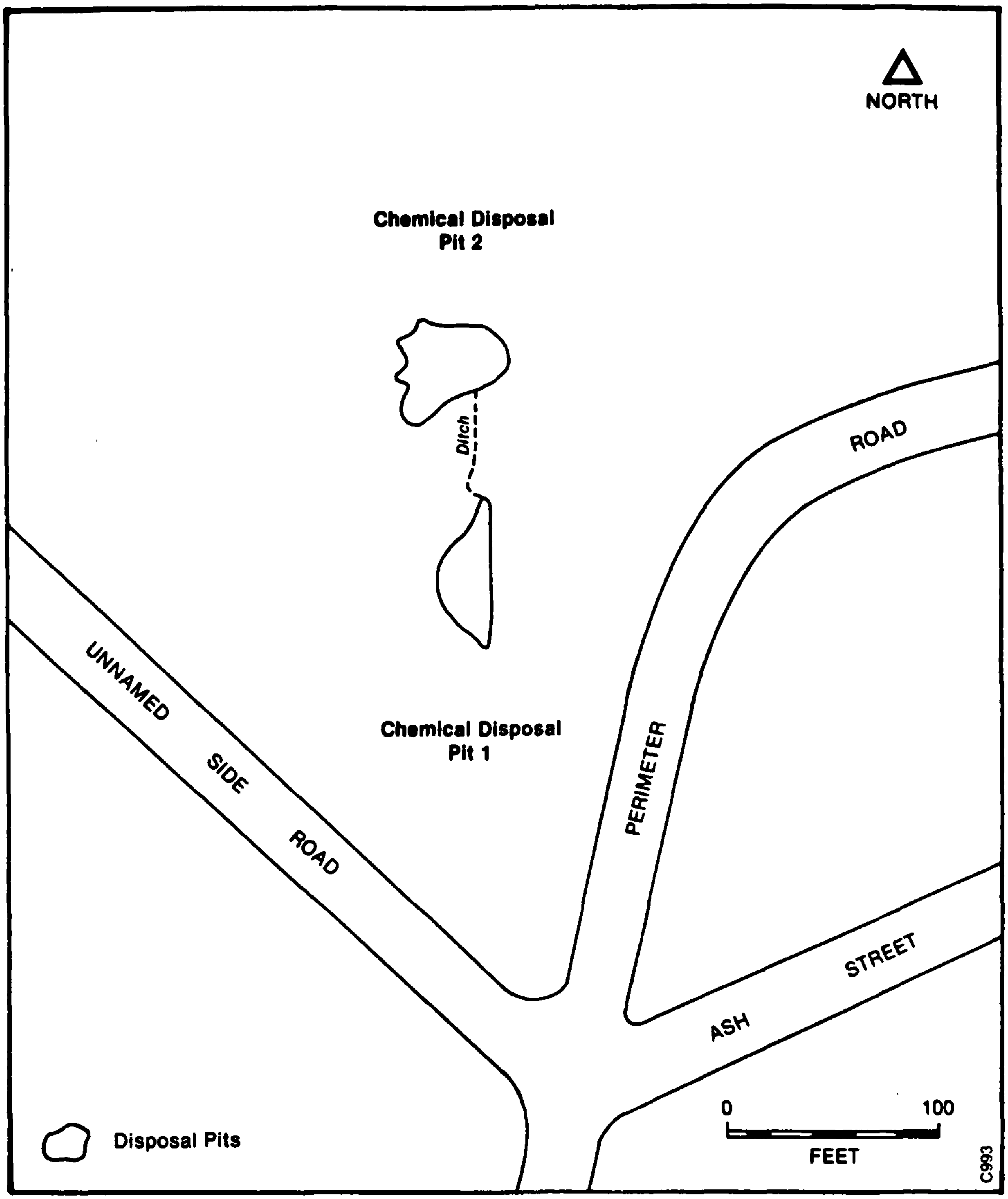

Figure 4-1. Chemical Disposal Pits Nos. 1 and 2, General Locations, 1971.

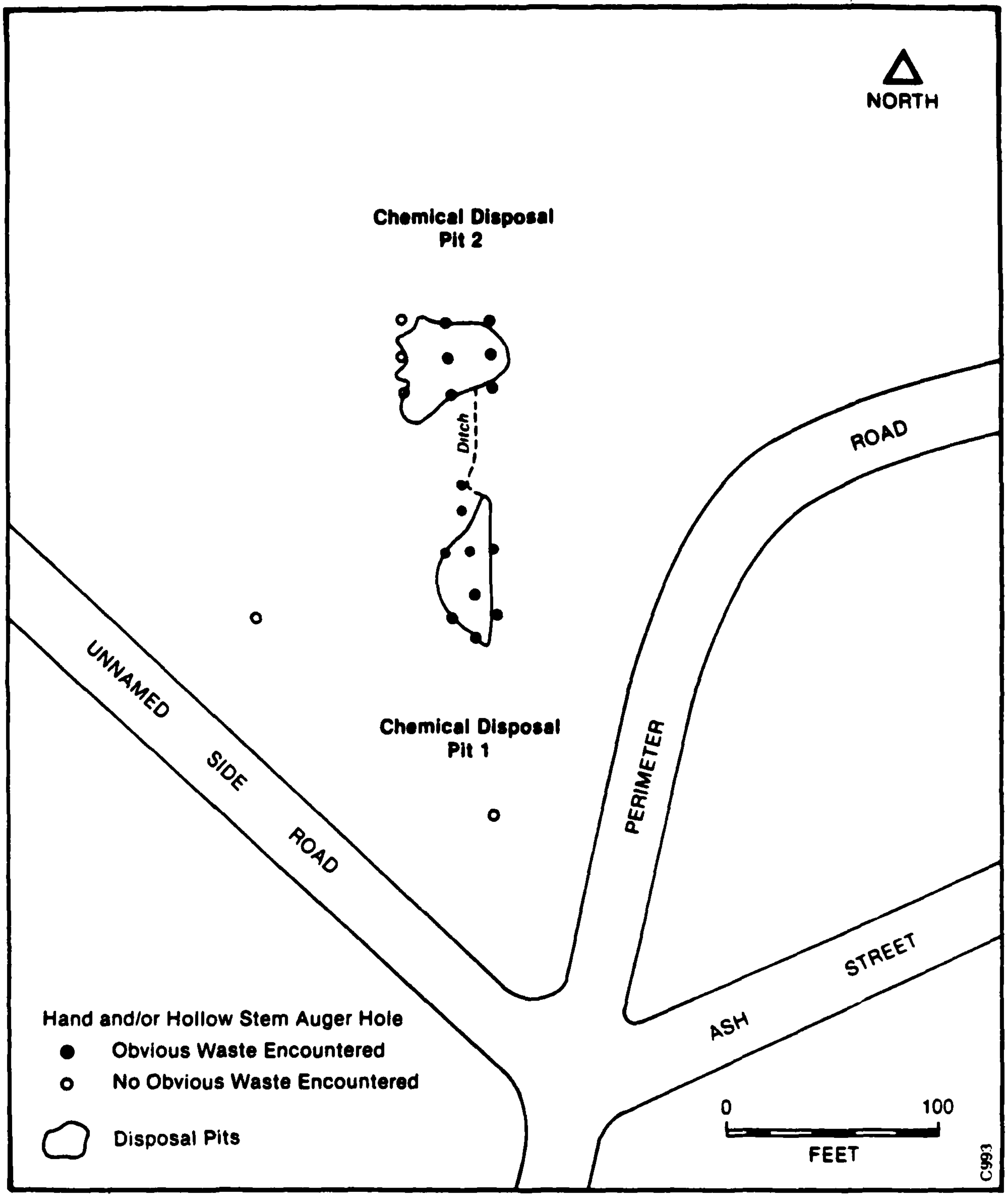

Figure 4-2. Chemical Disposal Pits Nos. 1 and 2, Hand Auger Results.

shallow aquifer and the lower artesian aquifer under the clay. The locations of four new IRP Phase II monitor wells (M-1, M-2, M-3 (deep), and M-4) associated with the disposal pits and the corresponding study sub-area are depicted on Figure 4-3. This figure also depicts the other study sub-areas and monitor wells for this field investigation to be discussed later in this section.

The data from the new monitor wells assisted in defining the underlying clay and provided a significant insight in the groundwater flow system. The result was the identification of a previously unknown subsurface clay "mound" about elevation 4,770 (Figure 2-3) and next to it an apparent trough at about elevation 4,765 line. These features are located northeast and just north of the disposal pits, respectively. These features on the clay bed can provide structural control to groundwater flow.

The clay mound and trough may become more significant to groundwater flow in the dry late summer season when groundwater levels are probably at their lowest. Groundwater may well be at or below the top of the mound, thus tending to flow along the trough to the northeast or around the mound to the northwest. Any chemical constituents resulting from Chemical Disposal Pits Nos. 1 & 2 will tend to follow the same path.

The static water levels measured in April 1983 indicated a saturated thickness in the area of the pits of about 15 feet, decreasing to about 5 feet to the northwest. The apparent reduction in saturated thickness to about 5 feet northwest of the pits implies a change in hydrogeologic conditions. This can be due to changes in the aquifer characteristics such as porosity, permeability, lateral extent, and thickness. The relative drop in the static water level elevation at monitor well M-2 (Figure 2-8) also suggests a change in hydrogeologic conditions. The exact hydrogeologic controls are not presently known but could possibly be related to the South Weber Landslide Complex which ends in the area (Pashley, 1971).

The data collected in the subsurface was very well controlled and defined, particularly the clay and groundwater level information.

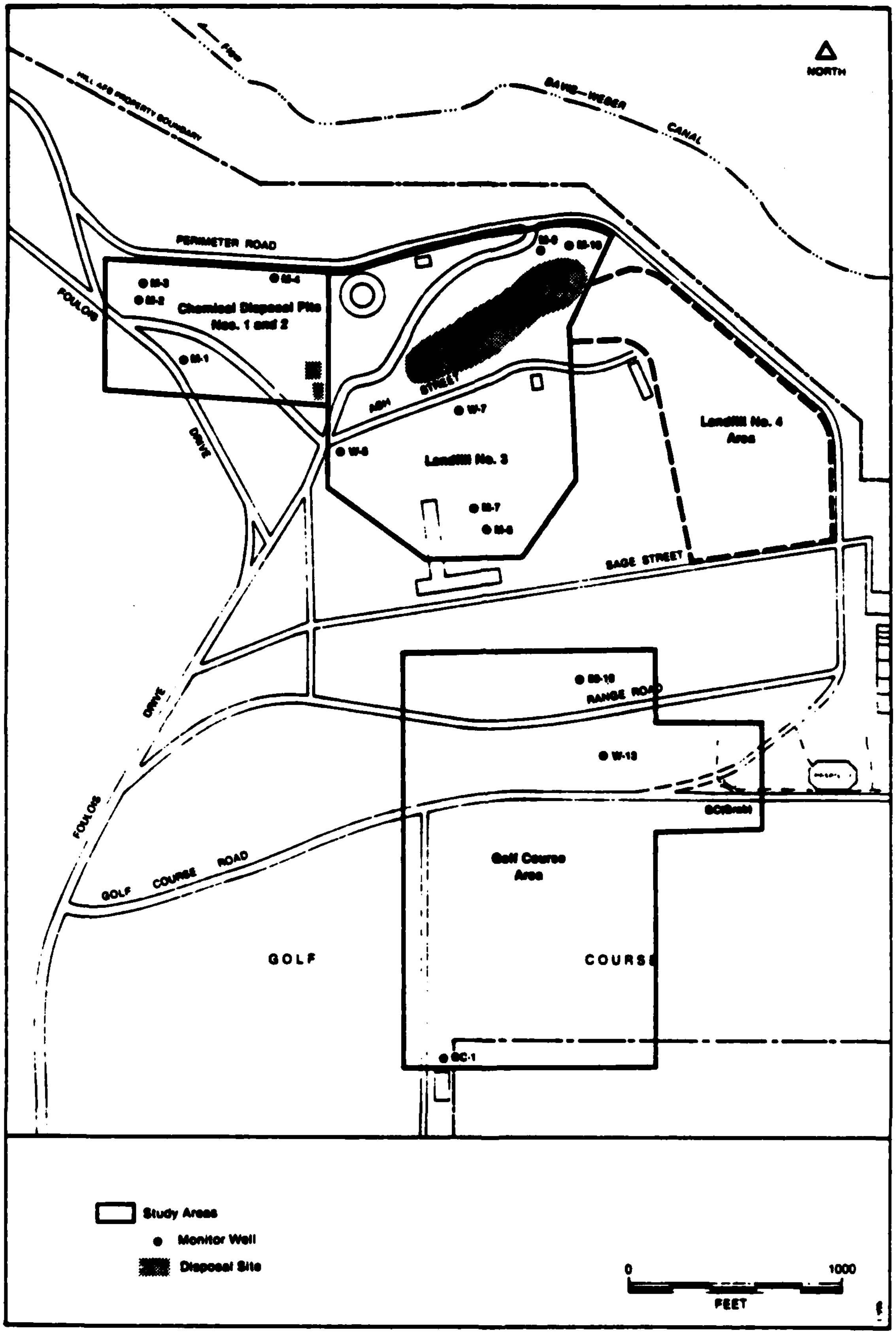

Figure 4-3. Study Sites and Associated IRP Phase II Monitor Wells.

Although additional data would be required to define the configuration of the clay surface between the monitoring points used in this study, present data are judged to be sufficiently reliable to make the hydrogeological assessments for this investigation.

Groundwater samples were collected twice during the initial investigation. The results indicate the presence of chemicals in the groundwater that can be attributed to Chemical Disposal Pits Nos. 1 & 2. These are discussed further in subsections 3.1.3.2, 4.1.1.3, and 4.2.

4.1.1.2.3 Chemical Disposal Pits No. 1 & 2 Oil Slick

An oil slick at Chemical Disposal Pits Nos. 1 & 2 was detected in Monitor Wells W-4 and 80-20 (Figure 4-4). The presence of oil in these wells has been noted from about 1976 to the present (OEHL, 1976; Calscience, 1981; Davis, 1982). No detailed studies pertaining to the oil slick had been conducted prior to this investigation.

A 0.5 foot-thick oil slick on top of the groundwater was measured in Monitor Well W-4 in November 1982. In May 1983, no oil was detected in W-4, but an apparent increase in oil thickness was noted in Monitor Well 80-20. It was believed that the oil in W-4 had been mobilized due to the unusually wet year which Utah experienced in the winter of 1982-1983. Therefore an extended oil thickness and water level measurement program was recommended and approved by the Air Force. These field activities took place from July to mid-November 1983.

Field Measurements

There were 14 sets of measurements taken under the initial IRP and extended oil and groundwater measuring programs. Figure 4-5 depicts the measurement dates. Also shown is a single measurement at Monitor Well No. 4 in November 1982, which was collected at the beginning of the IRP field program. The periods of field measurements were tailored to the expected changes in oil and water levels. Water levels and oil thickness data were collected principally by Radian personnel, with periodic assistance by Hill AFB Bioenvironmental and Civil Engineer personnel. The measurements were obtained at Monitor Wells M-1, M-2, M-3, M-4, W-4 and 80-20 (Figure 4-4).

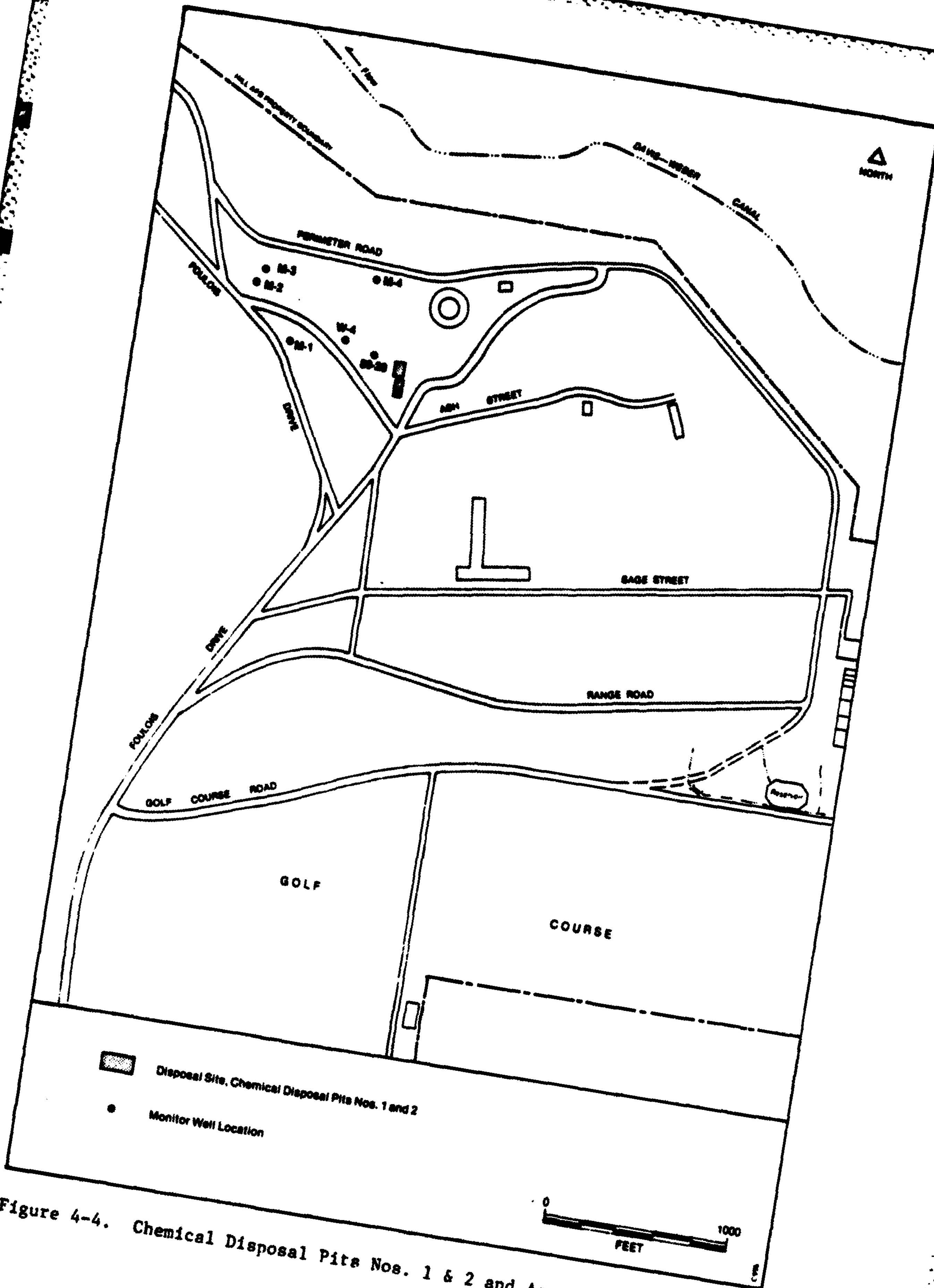

Figure 4-4. Chemical Disposal Pits Nos. 1 & 2 and Associated Monitor Wells.

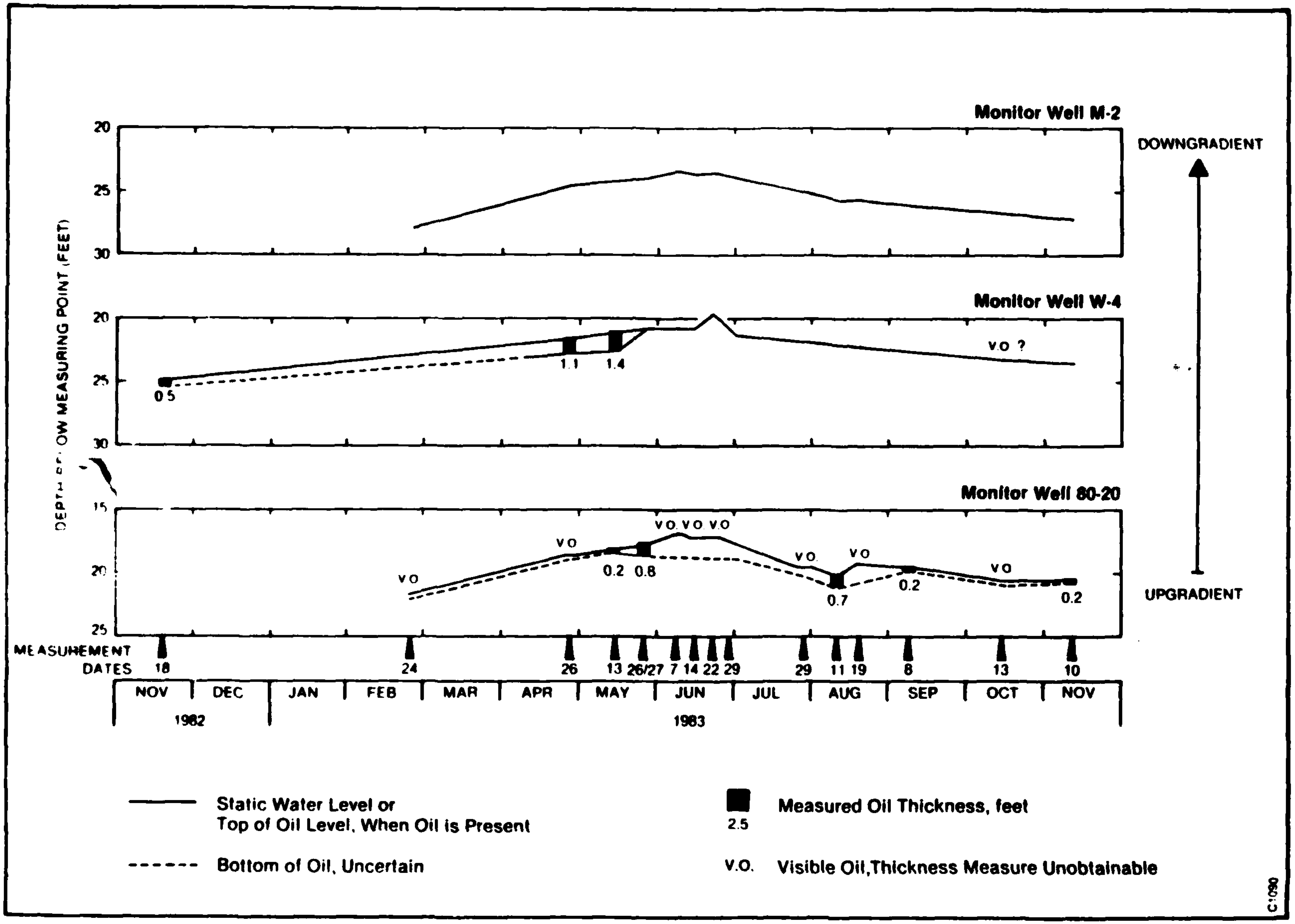

Figure 4-5. Selected Hydrographs of Monitor Wells in the Vicinity of Chemical Disposal Pits Nos. 1 & 2.

Oil thicknesses were difficult to measure due to local precipitation effects and the generally dirty aspects of the oil. Generally, a good measurement could only be obtained under ideal conditions on the first try. Subsequent readings were difficult to obtain because the first measurement disrupted the static oil, mixing it with the groundwater. Measuring activities also coated the inside of the casing making additional readings difficult.

Oil Thickness Measurement Results

During this program no oil was detected in Monitor Wells M-1, M-2, M-3, and M-4. Groundwater and/or oil levels crested in June 1983 and slowly declined through November. Figure 4-5 depicts the selected hydrographs of Monitor Wells M-2 (downgradient), W-4 and 80-20 (upgradient). Also shown are the measured oil slick thicknesses, and pre-program measurement data. It can be seen that the effects of the unusually high annual precipitation were still felt in November when the last water level measurements in the monitor wells were higher than at the beginning of the IRP field program in February 1983.

The hydrographs on Figure 4-5 clearly show the cresting of the ground water in June 1983 due to recharge from winter and spring precipitation. The cresting at essentially all wells was some 4 feet above the water levels at the beginning of the program, indicating a relatively high groundwater level. The groundwater could intrude into waste sites and/or contaminated soil zones. The lowest groundwater levels, normally expected during an extremely dry year, were not encountered during this program.

Measured oil thickness ranged from 0.2 feet early in the program increasing to about 1.4 feet during the groundwater crest period. Monitor Wells W-4 and 80-20 exhibited three to four-fold increases, respectively in apparent oil thicknesses during the program. Oil in Monitor Well W-4 was not detected after late May. However, oil thickness in Monitor Well 80-20 increased about two weeks later (Figure 4-5). Thereafter, Monitor Well 80-20 showed an apparent decrease in oil thickness by November 1983 as groundwater levels were declining. No oil was detected in Monitor Wells M-1, M-2, M-3, and M-4 throughout the program.

Explanation of Results

It should be noted that the measured oil thickness in the wells probably represents a "maximum thickness" of the oil layer on the ground water surface. Oil thickness measurement in a well are greater than the corresponding oil thickness in the aquifer outside of the well (American Petroleum Institute, 1980). For example, the mobile oil product in the capillary zone just above the water table may be less than an inch while the thickness measured in a well may be several inches or more (American Petroleum Institute, 1980).

Results of the various field measurements suggest that the oil may have migrated upgradient as the groundwater rose from Monitor Well W-4 towards Monitor Well 80-20. If the oil slick migrated upgradient as a lens this could account for the disappearance of the oil at Monitor Well W-4. The migration could be controlled by groundwater rising and/or local stratigraphic conditions. There is insufficient detail in the monitor well logs for W-4 and 80-20 to verify stratigraphic control. Measureable oil had not returned at Monitor Well W-4 by the end of the field program in November. The lag time before oil returns may exceed the present program duration. Another probable mechanism is that the unusually high groundwater levels may have lifted the free oil into a new dry formation. This new zone could have numerous pore spaces and abundant surface area that would permit oil capture. This could effectively immobilize or at least reduce the oil mobility. Although downgradient oil migration is a consideration, it doesn't appear likely from the data collected. Also, oil was not detected at downgradient Monitor Wells M-1, M-2, M-3 and M-4 during this program.

Based on the available data, the oil is not a free-moving hydrocarbon lens. It represents residual oils that have become trapped in the soil matrix. The hydrocarbons eventually moved through the soils and into Monitor Wells W-4 and 80-20. Further flushing of the visible oil from the formation most likely did not occur because groundwater level changes haven't been great (until winter/spring 1982-1983), because the site is not located on a major groundwater flow axis and because of local permeability conditions of the formation. Although the visible oil was

not observed to migrate laterally, soluble components of the old oil could continue to leach into the groundwater.

End-of-Year Ground Water Measurements

The original water level measurement program (IRP Phase IIB) was designed to include data from the low water periods (i.e., summer groundwater level measurements and data collection at Chemical Disposal Pits Nos. 1 & 2 and at all of the IRP monitor wells. Also, as practical, all pre-IRP monitor wells on the Base were to be assessed. However, because of the unusually high groundwater levels resulting from winter precipitation, the final groundwater level measurements was deferred until November. This documentation of the oil and water level changes at Chemical Disposal Pits No. 1 and 2 provided a "yardstick" for comparison of data from other sites.

The final round of static water level measurements and data collection was conducted on 10 November 1983 (Table 4-1). Field measurement priority was given to the monitor wells at Chemical Disposal Pits Nos. 1 and 2, then to the other IRP Phase IIB monitor wells, and finally, as time and budget permitted, to pre-IRP monitor wells at Hill AFB.

Generally it appears that groundwater temperatures and conductivities rose over the study period. These parameters can be influenced by normal seasonal variations or local conditions around the waste sites. Groundwater levels at all waste sites in November had declined from the previous synoptic measurements in late April 1983. The groundwater decline correlates with those observed at Chemical Disposal Pits Nos. 1 and 2 (previously discussed). Therefore, the final set of groundwater level measurements reflects the drier period of the 1982/83 water year, but not necessarily groundwater levels representative of a "dry" year.

4.1.1.3 Chemical Analyses and Reliability.

4.1.1.3.1 Chemical Analyses. The results of the analyses of soil samples from Chemical Disposal Pits No. 1 & 2 are presented in Table 4-2. (Also in Table F-1, Appendix F, Volume II of this report.)

Table 4-1.

Summary of November 1983 Monitor Well Field Measurements

Area	Monitor Well/ Piezometer	Depth to Water Below M.P. (feet)	Field In-Situ Temperature (°C)	Field In-Situ Conductance µmho/cm @ 25°C
Chemical Disposal Pits Nos. 1 & 2, Landfill Nos. 3 & 4, and Golf Course Areas				
	GC-1	40.76	10.0	710
	M-1	24.01	12.5	660
	M-2	27.17	13.0	1,010
	M-3	33.55	11.0	630
	M-4	25.00	11.0	1,120
	M-6	19.52	11.0	740
	M-7	19.02	12.0	900
	M-9	3.16	11.0	490
	M-10	15.14	12.0	1,320
	W-4	23.51 (oil)	13.5	550
	W-7	21.40	13.0	660
	W-8	22.86	13.0	560
	W-10	22.74	13.0	820
	W-12	22.12	12.0	860
	80-3	25.56	13.5	1,870
	80-4	26.01	13.0	1,820
	80-5	26.07	13.0	1,100
	80-6	27.95	13.0	1,070
	80-7	24.22	12.5	1,120
	80-8	25.09	12.0	8,610
	80-9(?)	24.09	13.0	2,210
	80-11	21.80	13.0	1,170
	80-12(?)	23.31	12.0	2,380
	80-13(?)	22.50	12.8	26(?)
	80-14	21.37	12.0	930
	80-15	19.63	12.0	820
	80-16	19.70	12.5	920
	80-20	20.56 (oil)	14.0	500
	80-22	24.26	14.0	960
	80-23	Destroyed		
	80-24(?)	29.49	12.5	1,120

Table 4-1 (continued)

Area	Monitor Well/ Piezometer	Depth to Water Below M.P. (feet)	Field In-Situ Temperature (°C)	Field In-Situ Conductance µmho/cm @ 25°C
Chemical Disposal Pit No. 3				
	P-1	20.87	12.0	2,320
	P-2	24.11	11.8	980
	P-3	7.15	12.2	1,120
	P-4	12.19	12.8	1,040
	P-5	23.19	11.0	970
	P-6	22.31	11.5	1,200
	P-7	19.45	11.0	1,120
	P-8	24.47	11.0	820
	P-9	23.90	11.0	820
	P-10	25.50	10.0	880
Berman Pond Area				
	BPM-1	55.75	Depth to water is greater than probe line.	
	BPM-2	95.23	Depth to water is greater than probe line.	

Table 4-2

Summary of Soil Sample Analyses for Chemical Disposal Pits No. 1 & 2 (Fall 1982)

Analysis	Units	CP1	CP2	CP3	CP4	CP5	CP6	CP7	CP8	CP9	CP10	CP11	CP12	CP13	CP14	CP15	CP16	CP16A	CP17	CP18	CP19	CP20
TOC	µg/g	4000	8400	4200	9900	8000	9100	17000	8900	15000	10000	10000	3600	3000	16000	24000	3300	6600	23000	2900	9300	17000
TOX	µg/g	<5	<5	<5	<5	<5	<6	<6	<5	<5	<5	<5	<5	<5	<6	<6	<5	<5	11	<5	<6	<6
O & G	mg/g	<5	22	<5	10	12	18	130	85	120	50	16	<5	<5	120	260	<5	<5	370	<5	<6	76
Phenol	µg/g	<11	<10	<10	<11	<11	<11	<11	<11	<11	<10	<11	<11	<11	67	34	<11	<11	380	<10	<11	<12
Moisture	%	4.9	1.7	1.5	6.4	8.8	10	12	7.5	6.0	3.9	5.3	5.3	5.4	11	13	6.6	7.6	19	4.5	12	16

Note: Results have been corrected for % moisture.

The detailed results of the analyses of the first round of water samples from Chemical Disposal Pits No. 1 & 2 (monitor wells M-1 through M-4) are presented in Appendix Table F-4. Analyses for a set of water quality parameters (iron, manganese, calcium, magnesium, sodium, potassium, carbonate, bicarbonate, chloride, fluoride, nitrate, hardness and silica) were performed on water samples from monitor wells M-2 and M-3 in order to assess the effect of recharge from the Golf Course Area upon this site.

The detailed results of screening analyses by ICP and GC/MS for monitor well M-2 are presented in Appendix Tables F-7 and F-9, respectively. As a result of the screening analyses, the following parameters were added to the list of analyses for the second round of sampling: barium, cadmium, iron, manganese, zinc, magnesium and calcium.

The detailed results of the analyses of the second round of water samples from Chemical Disposal Pits No. 1 & 2 are presented in Appendix Table F-12. A summary of the analyses of water samples is contained in Table 4-3.

4.1.1.3.2 Reliability. As noted in Section 3.5, the soil analyses were sufficiently reliable to assist in the location of the disposal pits. The water analyses were generally reliable with specific exceptions noted below.

The analysis for volatile aromatics by EPA Method 602 was subject to some doubt because of instrument problems in the laboratory. For the first round of sampling, the samples for volatile aromatics were collected a second time because the holding time was exceeded. Thus, the EPA 602 results correspond to a point in time a few weeks later than some of the other samples. This is not viewed as a serious problem because the entire first sampling episode spanned several weeks. In the second round of analyses, the EPA 602 sample holding times were exceeded again due to instrument problems. Most of the second round of samples were collected in one day, with some of the lysimeters taking a few days longer. In this situation, the samples were held at 4°C until the instrument was operational and then they were analyzed. The holding time of two weeks was exceeded by three to four weeks.

Table 4-3

Summary of Water Sample Analyses and Organic Compounds Detected in Groundwater for Chemical Disposal Pits No. 1 & 2

Analysis	Units	M-1	M-2	M-3	M-4
TOC	mg/L	14-20	43-51	2-4	8-10
TOX	µg/L	110	950	90	170
O&G	mg/L	<5-76	<5	<5	<5
Phenol	µg/L	150-410	920-1,200	20	20-40
TDS	mg/L	--	670-840	340-380	--
Sulfate	mg/L	--	8	42-45	--
Barium	µg/L	<100	<100	<100	<100
Cadmium	µg/L	<10	10	<10	<10
Iron	µg/L	1,900	2,300-18,000	<100	100
Manganese	µg/L	370	1,100-1,600	140-170	850
Zinc	µg/L	320	270	200	270
Conductance	µmho/cm	740-1,000	960-1,300	580-640	730-1,300
Calcium	mg/L	100	170-180	52-59	110
Magnesium	mg/L	29	26-31	28	29
Sodium	mg/L	--	27-49	43	--
Potassium	mg/L	--	4-5	7-8	--
Carbonate	mg/L	--	25-44	18-21	--
Bicarbonate	mg/L	--	440-520	200-220	--
Chloride	mg/L	--	56-79	46-50	--
Fluoride	mg/L	--	0.2	0.3	--
Nitrate	mg/L	--	0.03-0.61	<0.02-0.36	--
Hardness	mg/L	--	530-580	250-260	--
Silica	mg/L	--	26-29	11-15	--

"--" Denotes an analysis which was not specified for the sample

Table 4-3 (continued)

Analysis	Units	M-1	M-2	M-3	M-4
EPA 601					
Methylene Chloride	µg/L	2			
1,1,1-Trichloroethane	µg/L	3	20-26,000		8.8-57
Carbon Tetrachloride	µg/L		92	5-78	18-110
Trichloroethylene	µg/L	1.3	33		49
Trichlorofluoromethane	µg/L		56		
1,1-Dichloroethene	µg/L		110		9
1,1-Dichloroethane	µg/L	35			4,300
trans-1,2-Dichloroethene	µg/L	410	34,000	350	
1,2-Dichloroethane	µg/L	33			
1,2-Dichloropropane	µg/L		41		
Tetrachloroethene	µg/L		190		25
Chlorobenzene	µg/L	850-1,700	11-170	1	
1,2-Dichlorobenzene	µg/L	370-950	890-1,900		5-17
EPA 602					
Benzene	µg/L	82-220	14,000-25,000	62-580	120-1,700
Toluene	µg/L	5-13	580-920	2	7
Ethyl benzene	µg/L	3-68	15-64		
Xylenes	µg/L	69-250	74-130		7

Note: No entry for a compound denotes not detected.

Table 4-3 (continued)

(micrograms per liter)

GC/MS Purgeable Compounds	Detection Limit	M-2
1,1-Dichloroethene	8	25
1,1-Dichloroethane	8	1900
trans-1,2-Dichloroethene	8	7400
Chloroform	8	240
1,2-Dichloroethane	8	58
1,1,1-Trichloroethane	8	23
1,2-Dichloropropane	8	26
Trichloroethylene	8	(5)*
Benzene	8	133
Tetrachloroethene	8	(6)*
Toluene	8	520
Chlorobenzene	8	30
Ethylbenzene	8	44
GC/MS Additional Purgeable Compounds		
Dichlorobenzenes		300-1400
GC/MS Base/Neutral Extractable Compounds		
1,3-Dichlorobenzene	1	22
1,4-Dichlorobenzene	1	180
1,2-Dichlorobenzene	1	880
1,2,4-Trichlorobenzene	1	41
Naphthalene	3	6

*Though below the calculated detection limit, these compounds were identified and are reported as qualitative results.

Table 4-3 (continued)

	Detection Limit	M-2
GC/MS		
Additional Base/Neutral Compounds		
Tributylphosphate		2-6
Organic acids (not fatty)		100-400
Xylenes		2-8
C_3 substituted benzenes		2-8
GC/MS		
Acid Extractable Compound		
Phenol	1	12
2,4-Dimethylphenol	1	8
GC/MS		
Additional Acid Compounds		
Methyl phenol		Present
C_3 substituted phenols		4-16
	(milligrams per liter)	
ICP Analysis		
Sodium	1.3	50
Potassium	2.5	6.6
Calcium	0.3	200
Magnesium	0.5	36
Iron	0.03	30
Strontium	0.02	0.5
Barium	0.6	1.5
Manganese	0.3	1.2
Zinc	0.2	0.3
Boron	0.2	0.3

One intent of the second sampling episode was to note the effect of the spring runoff upon the parameters measured. It was decided that there was more value in analyzing out-of-date samples collected with the others than in analyzing samples collected later under different water table conditions. The reported values from EPA Method 602 in the second round of samples should be regarded as minimum values. The chemical analysis as performed in the laboratory was reliable. However, no standard samples were analyzed to evaluate the effect of the extended storage times.

Monitor well M-2 showed high levels of benzene in the 602 analysis. The presence of benzene was confirmed by the GC/MS, though at a much lower concentration. The chromatograms were complex. Therefore, the values reported for benzene should be regarded as an upper bound.

The result of the analysis of TOX in water in the first round of samples proved to be of limited reliability. Therefore, the complete list of 29 analytes from EPA Method 601 was determined in the second round of samples instead of the TOX.

4.1.2 Landfill No. 3

4.1.2.1 Geophysical Results and Reliability.

4.1.2.1.1 Geophysical Results. Landfill No. 3 is located south of Fire Training Area Number 1. This area has been a source of gravel used in road and runway construction. Subsequently, the area has been used as a landfill site. Solid waste including scrap metal, construction waste such as old concrete and asphalt and large quantities of industrial sludge and chemicals have all been dumped in this landfill. Part of the landfill appears to have been backfilled, particularly along the southern and western boundaries.

Electrical Resistivity Survey. A total of five lines of dipole-dipole data were obtained across Landfill No. 3 using 30-foot dipole spacings. Two of these lines (1 and 2) had multiple electrode spreads to increase the line length. All lines trend N20°W across the landfill and each line is spaced 200 feet from the adjoining line (Figure G41). Outlined on this figure is the edge of the excavated portion of the landfill. This excavation has accounted for up to 20 feet of elevation difference between the northern and southern halves of the surveyed area.

The observed apparent resistivity data for Line 1 are shown on Figure G42. These data are highly erratic within the excavated area. Values vary from less than 10 ohm-meters to over 400 ohm-meters. The lower values occur for the most part as anomalous diagonals and do not necessarily suggest a continuous underlying clay layer. The sporadic nature of the data from the near-surface separations is perhaps best explained by the abundant construction and metal waste present. Several metal containers and numerous pieces of concrete and iron are exposed in small piles of dirt that have obviously been trucked to this site. This refuse could distort readings for the shallow separations. The southern half of Line 1 shows a much more homogeneous nature. Observed apparent resistivities are well in excess of 400 ohm-meters. Isolated areas in excess of 800 ohm-meters are noted however and likely represent unsaturated zones in sand or gravel. No clear evidence for an underlying clay layer is present but this is due to the sounding depth limitations of the 30-foot dipoles (approximately 60 feet) rather than the total absence of a clay layer.

Line 5 is located 200 feet east of Line 1. The observed data are presented as Figure G46. The apparent resistivity on Line 5 are much more uniform and show values generally less than 100 ohm-meters. In the northern half of the line, near surface apparent resistivities averaging about 60 ohm-meters grade rapidly with depth into an underlying layer (probably clay) averaging about 25 ohm-meters. Topographic effects are present near the center of the line where apparent resistivities in excess of 200 ohm-meters are noted. This area coincides with the change in slope at the edge of the excavated area. Farther to the south the apparent resistivities have increased to over 100 ohm-meters and were the line to be extended, values in excess of 400 ohm-meters could be expected.

Line 2 is located 200 feet east of Line 5. The northern portion of the line (Figure G43) indicates a fairly homogeneous layer averaging about 28 ohm-meters. The water table is shallow along the northern end of this line and in fact occurs at the surface near the dirt road (Figure G41) forming a small marshy area having about 6 inches of standing water. Beneath station 0, apparent resistivities average about 13 ohm-meters.

While this conductive zone may be in part due to topographic effects from the edge of the excavated area, it also appears to be the first good indication of a clay layer within the landfill area. The area between stations 1 and 5 south contains material that averages about 60 ohm-meters. This material extends south from the edge of the excavated area and may be remanant of the excavated material. Still farther to the south the apparent resistivities increase rapidly to well over 400 ohm-meters, and the material encountered is, in all likelihood, a continuation of the resistive material first noted on Line 1. The decrease in resistivity at depth on the southernmost end of the line is caused by conductive material. This material is likely to be a clay layer near the limit of detection (approximately 60 feet).

Line 4 is the next line to the east. The observed data are shown in Figure G45. The conductive material noted on Line 2 is also present on Line 4. It seems to be located adjacent to the edge of the excavated area. It can however be traced back into the undisturbed ground to the south along the full length of the line. The resistive near-surface interval occurring between station 0 and 2 south is coincident with the edge of the excavated area and is thought to be due, in part, to topographic effects.

The next line east is Line 3. The observed data are shown as Figure G46. These data also show that much of the line is underlain by the conductive material first noted on Lines 2 and 4. This material appears to approach the surface on the southern end of the line. It appears that this material is underlain by a slightly more resistive layer. Again, topographic effects are thought to contribute to the higher resistivities observed on the shallower separations in the center of the line.

Numerical models were computed for Lines 1, 2 and 3. These models are shown as Figures G47, G48 and G49 respectively, and take into account the variation in topography across the landfill. These models show in section view the variation in resistivity needed to produce a reasonable fit to the observed data. Figures G50 and G51 are maps of the intrinsic resistivity distribution taken from the numerical models at depth intervals of 18-30 feet and 45-60 feet. These figures are plan views of

the resistivity distribution and show the general trend from resistive sand or gravels on the west to the more conductive clay bearing soils on the east and north.

Ground Magnetic Survey. Ground magnetic data were also taken along resistivity lines 1, 2 and 3. Magnetic results are presented both in profile (Figures G52, G53 and G54) and in plan view (Figure G55). These data show a magnetically disturbed area extending from south of the excavated area, near the oiled road, northward to the dirt road leading to the parked airplanes. The magnetic disturbance noted is undoubtedly caused by the iron waste discarded in the landfill. The magnetic data tend to suggest that the excavated area was larger than presently exists, and fill, including metal refuse, was dumped south of the present escarpment and subsequently graded. Grounded structures such as powerlines and buried pipelines may contribute to part of the magnetic disturbance near the oiled road. These however would not account for the continuous nature of the observed magnetic disturbance.

4.1.2.1.2 Reliability of Geophysical Results. The numerical models computed for the respective electrical resistivity lines are good fits to the observed data and show agreement between calculated and observed values that average ± 10%.

The ground magnetic data are repeatable to within 2 gammas except at stations adjacent to iron refuse. This variation is small compared to many observed anomalies (20 to 300 gammas) and is well within the desired survey accuracy.

4.1.2.2 Field Investigation Results and Reliability. Because of its close proximity to Landfill No. 4 and associated environmental complaints concerning Landfill No. 4 (Davis, 1983, AFLC, 1981), Landfill No. 3 was studied to determine if it has affected the local groundwater system. Previous studies and information on Landfill No. 3 were used and updated during this investigation. The area of study is depicted on Figure 4-3, which also shows locations of the new and old monitor wells utilized during this investigation. Two new monitor wells, M-9 and M-10, were installed on the north side of the site to detect any groundwater contamination in the shallow water table and lower artesian aquifers,

respectively, that might be attributed to Landfill No. 3. New monitor wells M-6 and M-7 south of the landfill, along with previous monitor wells W-7 and W-8 were used to provide groundwater data concerning upgradient conditions in order to assess changes in groundwater quality resulting from flow through the area of the disposal site.

This investigation indicates that there is little groundwater incursion into Landfill No. 3 (Figure 2-7). The groundwater levels measured in this investigation represent an extreme due to the unusually high winter precipitation. Also, the groundwater level change map (Figure 2-5) indicates that the least change was in the vicinity of the landfill area. Greater changes tend to occur east and west of Landfill No. 3 where Chemical Disposal Pits No. 1 & 2 and Landfill No. 4, respectively, are located. The small groundwater level increases at Landfill No. 3, relative to the other waste sites, support minimal leachate development.

Leachate has been observed near the toe area of the landfill in the spring (Davis, 1983). However, the primary source of this leachate would appear to be fluids from within the waste and infiltration of precipitation through the landfill cover. A water balance analysis had been previously conducted by Cal Science Research, Inc. (1981) for the Ai- Force in a study of Landfill No. 4. That study indicates that much of the leachate generated at Landfill No. 4 may be attributable to infiltration of precipitation through the present landfill cover.

Previous investigations (Morse, 1976; CRI, 1981) noted the near surface presence of groundwater as evidenced by free standing water at the toe area of Landfill No. 3. It appears from the recent data collected that the groundwater level is in fact near the ground surface (i.e., approx. 1.5 feet at monitor well M-9), but not necessarily discharging to form water pools. The toe area of the landfill is topographically low and bordered by Perimeter Road, which is slightly higher. The near surface soils observed also had a high clay content reducing the infiltration capacity of the soil. Therefore, a surface runoff tends to collect at the base of Landfill No. 3, forming large pools of water. These pools of water can potentially infiltrate slowly to the shallow groundwater system or infiltrate laterally into the landfill. Generally, this surplus water

should be considered as rejected recharge of the shallow groundwater aquifer.

Groundwater samples were collected from two sampling periods (February and April 1983) for this investigation. The results indicated the presence of chemicals in the groundwater that can be attributed to Landfill No. 3. This will be discussed further in subsections 4.1.2.3, 4.1.3.2, and 4.2.

4.1.2.3 Chemical Analyses and Reliability.

4.1.2.3.1 Chemical Analyses. The detailed results of the analyses of the first round of water samples from Landfill No. 3 (new monitor wells M-6, M-7, M-9 and M-10 plus existing wells W-7 and W-8) are presented in Appendix Table F-4. Analyses for the set of water quality parameters (defined above in Section 4.1.1.3) were performed on water samples from the four new monitor wells in order to assess the effect of recharge from the Golf Course Area upon Landfill No. 3. Wells M-7 and M-9 had been sampled for the first time when the decision was made to analyze for the water quality parameters. Therefore, they were resampled for the water quality parameters with the other wells.

The detailed results of screening analyses by ICP and GC/MS for monitor wells M-6 and M-9 are presented in Appendix Tables F-7 (ICP) and F-9 (GC/MS). As a result of the screening analyses, the following parameters were added to the list of analyses for the second round of sampling: barium and zinc.

The detailed results of the analyses of the second round of water samples from Landfill No. 3 are presented in Appendix Table F-13.

A summary of the analyses of water samples is contained in Table 4-4.

4.1.2.3.2 Reliability. As noted in Section 3.5, the water analyses were generally reliable. The problems with the analysis for volatile aromatics by EPA Method 602 and with the TOX analysis have been discussed above in Section 4.1.1.3.2.

Table 4-4

Summary of Water Sample Analyses and Organic Compounds Detected in Groundwater for Landfill No. 3

Analysis	Units	M-6[1]	M-7[2]	M-9[3]	M-10[4]	W-7	W-8
TOC	mg/L	1-10	2-3	13-14	1	3-5	2
TOX	ug/L	40	70	280	50	30	110
O&G	mg/L	<5	<5	<5	<5	<5	<5
Phenol	ug/L	10	<10-50	30-40	<10	<10	<10-10
MBAS	mg/L	<0.1	<0.1-0.2	0.3-0.4	<0.1	<0.1	<0.1-0.2
TDS	mg/L	360-370	480-550	2,500-2,900	680-810	320	480-500
Cyanide	ug/L	<10	<10	<10	<10	<10	<10
Sulfate	mg/L	32-41	39-60	160-480	76-88	21-58	40-50
Arsenic	ug/L	8-<10	<5	<10-28	9-<10	<5	<5-<10
Barium	ug/L	<100	<100	<100	<100	<100	<100
Beryllium	ug/L	<10	<10	<10	<10	<10	<10
Cadmium	ug/L	<10	<10-13	10-20	<10	<10	<10-13
Chromium	ug/L	<50	<50	<50	<50	<50	<50
Copper	ug/L	<20	<20	<20	<20	<20	<20
Iron	ug/L	<100	72-<100	<100-2,100	100	<100	<100
Lead	ug/L	<10	<10-<20	<10-<20	<10-<20	<10	<10-<20
Manganese	ug/L	220-230	<20-240	1,300-1,700	230-320	<20	20-46
Mercury	ug/L	<0.2-<10	<0.2-<10	<0.2-<10	<0.2-<10	<0.2-<10	<0.2-<10
Zinc	ug/L	80	90	80	30	30	30
Conductance	umho/cm	560-640	700-1,000	3,600-4,500	1,000-1,200	390	680-790
Calcium	mg/L	50-58	90-110	280-300	83-110	86	99
Magnesium	mg/L	29-30	30-34	130	47-64	12	24
Sodium	mg/L	38-40	55-89	470-490	74-79	--	--
Potassium	mg/L	7-8	2	10-19	12-13	--	--
Carbonate	mg/L	14-20	10-68	<1-17	22	--	--
Bicarbonate	mg/L	220-240	240-300	460-530	290-340	--	--
Chloride	mg/L	48-49	58-70	910-1,000	150-200	--	--
Fluoride	mg/L	0.4	0.4-0.5	0.2-0.3	0.3	--	--
Nitrate	mg/L	<0.02-0.25	2.1-3.3	0.04	0.03-0.28	--	--
Hardness	mg/L	240-270	350-410	1,200-1,300	400-540	--	--
Silica	mg/L	10-14	14-16	16-17	13-18	--	--

"--" Denotes an analysis which was not specified for the sample

1 Upgradient well screened in lower or artesian aquifer.

2 Upgradient well screened in shallow water table aquifer.

3 Downgradient well screened in shallow water table aquifer.

4 Downgradient well screened in lower or artesian aquifer.

Table 4-4 (continued)

Analysis	Units	M-6	M-7	M-9	M-10	W-7	W-8
EPA 601							
Methylene Chloride	µg/L			3			
1,1,1-Trichloroethane	µg/L					<2-3	16-20
Trichloroethylene	µg/L		1	52-125	<1-8		3-52
1,1-Dichloroethene	µg/L			2			<1
1,1-Dichloroethane	µg/L			6			3
trans-1,2-Dichloroethene	µg/L					4	8
1,2-Dichloroethane	µg/L			16			
Chlorobenzene	µg/L			14	<1-11		
1,2-Dichlorobenzene	µg/L	<5	<5	490	7-200	<5	<5
ErA 602							
Benzene	µg/L			37	<1-<36		1
Ethyl benzene	µg/L				<1-5		

Table 4-4 (continued)

(micrograms per liter)

GC/MS Purgeable Compounds	Detection Limit	M-6	M-9
1,1-Dichloroethane	8		15
trans-1,2-Dichloroethene	8		730
Trichloroethylene	8		170
Chlorobenzene	8		14
GC/MS Additional Purgeable Compounds			
Dichlorobenzenes			400-1600
GC/MS Base/Neutral Extractable Compounds			
1,3-Dichlorobenzene	1		48
1,4-Dichlorobenzene	1		170
1,2-Dichlorobenzene	1		890
1,2,4-Trichlorobenzene	1		7
Diethyl phthalate	1	0.5-2	
Di-n-butyl phthalate	1	1	
Butyl benzyl phthalate	7	0.5-2	
Bis(2-ethylhexyl)phthalate	1	4	
Di-n-octyl phthalate	3	3	

Table 4-4 (continued)

GC/MS Additional Base/Neutral Compounds	Detection Limit	M-6	M-9
Tris-2-butoxyethyl phosphate		2-8	
Caprolactam		2-8	20-80
Iodoacetone			Present
Quinone			2-8
Hexadecanoic acid		1-4	
Xylenes			6-25
C_3 substituted benzenes			3-10
Styrene			5-20
Alkyl benzenes			5-20
A cyclohexyl paraffin		0.5-2	
Phenyl paraffins		3-10	
Paraffin oil C_{20}-C_{40}		100-400	
GC/MS Acid Extractable Compounds			
2-Nitrophenol	2		3
Phenol	1	1	4
ICP Analysis	(milligrams per liter)		
Sodium	1.3	57	520
Potassium	2.5	9.8	13
Calcium	0.3	57	300
Magnesium	0.5	39	140
Iron	0.03		0.03
Silicon	0.3	9.3	9.4
Strontium	0.02	0.27	1.1
Barium	0.6	0.7	
Manganese	0.3	0.3	1.4
Zinc	0.2	0.7	0.6
Lithium	0.05		0.1
Boron	0.2	0.2	1.6

4.1.3 Golf Course Area

4.1.3.1 Geophysics Results and Reliability.

4.1.3.1.1 Geophysical Results. Two additional electrical resistivity lines were completed outside of the waste disposal pits or landfill areas under investigation. These lines were placed to aid the hydrologic study being conducted concurrent with the geophysical survey. The lines are located on the Golf Course and opposite the junction of Foulois Drive and Sage St. The purpose of these lines was to document the continuation of a clay layer encountered in a test well placed on the Gulf Course.

Electrical Resistivity Survey. The Golf Course line is a north-south line placed roughly in the center of the Golf Course. Station 8N is 50 feet south of the road leading to the Clubhouse and 265 feet east of the road leading to the maintenance building (Bldg. No. 710). The data for this line are shown on Figure G56. The clay layer is detected over the entire length of the line. This layer is very conductive, as indicated by many apparent resistivity values of less than 10 ohm-meters. The apparent reduced depth of the clay layer in the interval between stations 5 and 8 south is easily explained by undulations in surface topography which has placed this interval in a topographic low. Clay may be less than 10 feet deep in this interval, as compared to approximately 30 feet deep farther to the north or south.

The line located just north of Base well No. 4 is shown as Figure G57. These data show a layering effect between a resistive surface and a conductive deeper layer. There is an apparent northward increase in thickness of the resistive surface layer. This could be the result of either a thinning of the resistive material to the south or the effect of the layers dipping to the north.

The indication of clay layers on both the Golf Course line and the line near Base well No. 4 suggest either a thick sequence of clay or multiple clay layers extending over a minimum vertical distance of 70 feet.

A numerical model was calculated for the Base well No. 4 line. This model, shown as Figure G58, depicts the northward thickening of the resistive surface. The underlying conductive layer undoubtedly contains much more clay. This layer, which may outcrop or at least occur very near surface on the southern end of the line, is shown on the numerical model at a depth of about 45 feet under the northern end.

4.1.3.1.2 Reliability of Geophysical Results. Only the line near Base well No. 4 was modeled. The interpretation of these data is limited by use of a two-dimensional algorithm to model data from a three-dimensional environment. The results are a good approximation however of the intrinsic resistivity and thickness of the soil units beneath the line.

4.1.3.2 Field Investigation Results and Reliability. The Golf Course Area was investigated in order to estimate the potential for groundwater recharge to the waste disposal sites to the north at Chemical Disposal Pits No. 1 & 2 and Landfill No. 3 and, though not a part of this study, Landfill No. 4 as well. This was to be accomplished by first determining the existence of groundwater and second by using reconnaissance chemical analysis to graphically compare the chemistry of the groundwater as a possible indication of hydrologic connection.

Significant levels of groundwater underflow from the Golf Course could raise groundwater levels beneath the waste sites and cause incursions of groundwater into waste material, resulting in leachate generation and subsequent contamination of groundwater. Even during the dry summer months, underflow of Golf Course irrigation could result in high groundwater levels. Previous studies had noted the possibility of the groundwater contributions from the Golf Course Area but no field work had been conducted to verify its potential.

The primary means of investigating the Golf Course was through the emplacement of Well GC-1 at the Golf Course (Figure 4-3). The investigation provided physical and chemical data to characterize the groundwater system based on information from Well GC-1 and provided insight into other potential surface recharge points. The Golf Course

Area was found to contribute recharge to the topographically lower waste disposal site areas to the north. The recharge occurs directly (runoff) and probably indirectly (groundwater underflow) at the Golf Course from the following sources:

- Golf course club house septic tank,
- Base culinary water reservoir (formerly; now lined),
- Golf course parking lot runoff,
- Golf course irrigation,
- Weber Basin Water Conservancy District Reservoir, and
- Groundwater underflow.

Most of these areas are contained within Figure 4-3. The Golf Course parking lot, septic tank and the Weber Basin Conservancy District Reservoir are just a little east of the figure along the Golf Course Road.

Sufficient data are not available to fully evaluate the contribution of recharge made by each source, but sufficient evidence exists to suggest direct recharge does occur to the shallow aquifer that underlies the waste sites. Recharge from the septic tank, water reservoir, and parking lot runoff are presumed to be small relative to the total area investigated of some 230 acres. For instance, the largest contributor of these three is assumed to be the parking lot runoff which drains west along the Golf Course Road to a drainage culvert shown on Figure 4-3 (i.e., GC (Grab)). The direct runoff from the parking lot was computed to average about 0.4 Acre-Feet per year (Acft/yr). The Weber Basin Conservancy District Irrigation Reservoir is an open, unlined water reservoir. Because it is unlined, vertical leakage and subsequent recharge to aquifers cannot be discounted. The water cycle of the reservoir is unknown.

Golf course irrigation has the greatest potential for groundwater contributions to the waste site areas. This can be through direct and indirect paths. The direct path is the irrigation adjacent to the Golf Course Road where portions of the discharge often spray on the road which then drains to the north (Sugamoto, 1982). This has not been estimated but is assumed small compared to the indirect recharge. The indirect, and

probably the greatest, potential for groundwater recharge is by infiltration of the irrigation water. Insufficient data were available to evaluate golf course infiltration. Such an evaluation would necessitate conducting a water balance assessment.

Because no previous information concerning aquifers at the Golf Course were available, one well (GC-1) was installed to provide hydrogeological data and groundwater samples. In addition, samples were collected from two previously existing monitor wells (W-13 and 80-19). A runoff sample was also collected from the Golf Course parking lot (Figure 4-3; GC (Grab)) for chemical analysis. The locations are depicted on Figure 4-3. The presence of groundwater at Well GC-1 is initial evidence that recharge could be occurring from the Golf Course Area. The groundwater level profile at Well GC-1 versus the waste site areas is shown on Figure 2-7. It can be inferred that groundwater levels could be projected as a smooth curve from the Golf Course to the low areas, denoting hydraulic connection. As Well GC-1 is about 1,700 feet from Monitor Well W-13 and because there are no direct control data between them, the existence of hydraulic connection between the two cannot be definitely determined. The groundwater at Well GC-1 may occur as a perched aquifer in sand channel deposits of the Weber Delta. Additionally, sand deposits could be continuous in old Weber Delta stream channels. These buried stream channels could be hydraulically connected to down gradient areas such as the area under Berman Pond. This was noted in Section 2.3.2 where similar static water level changes were found between Monitor Well BPM-2 at Berman Pond and the Golf Course Well, GC-1.

Since a 50-foot section of clay was found at Well GC-1, it was desirable to find out if any sandy soils existed north of Well GC-1 to the Golf Course Road. This could serve as a recharge area. Therefore, indirect control data were provided by a north-south electrical resistivity survey conducted at the Golf Course. It was positioned between Well GC-1 and the Golf Course Road as discussed in Section 4.1.3.1. The results suggested that clay type materials exist north of Well GC-1 on the Golf Course. The exact nature of the clay is unknown, but if it were extensive throughout the area, then natural groundwater

recharge may be coming from off-Base since the clay would limit local recharge.

Analytical results were evaluated in an effort to correlate the chemical characteristics of the recharge from the Golf Course to the chemical characteristics of groundwater beneath the waste site. Monitor wells downgradient from the waste sites also included for comparison were monitor wells M-2, M-3 (deep), M-6 (deep), M-7, M-9, and M-10 (deep) which are also shown on Figure 4-3. The results of the analyses for major cations and anions were plotted on a Piper Trilinear diagram (Piper, 1953) as percentage reacting values (Figure 4-6). By extending the cation and anion points into the triangular portion of the diagram, a single point at the intersection represents the "chemical type" of the water sample. This method was used as a reconnaissance tool to assess the possibility that the Golf Course Area provides groundwater recharge to the lower areas. By this method, in the simplest case, the water quality of two different waters would appear on the diagram in two distinct areas. Any mixing of the waters would theoretically fall on a line between the two end members.

Figure 4-6 suggests that groundwater recharge from the Golf Course may flow beneath the waste areas. The elongated clustering of data points on Figure 4-6 shows on one end water from Well GC-1 and at the other end water from the downgradient monitor wells M-2, M-3, M-6, and M-7. Samples from Monitor Wells 80-19, and W-13 plot in the intermediate area of the diagram along with the parking lot runoff sample. This diagram, although not conclusive, suggests that the water in the Golf Course Area is not significantly different chemically from groundwater to the north but it does generally show a gradual transition in water chemistry from south to north.

An additional observation from the trilinear diagram analysis is that water from monitor wells M-2 and M-9 generally plot away from water in the other wells. These wells are downgradient from Chemical Disposal Pits No. 1 & 2 and Landfill No. 3, respectively. The differences in water chemistry evident on the diagram are most likely the result of impacts from the disposal sites.

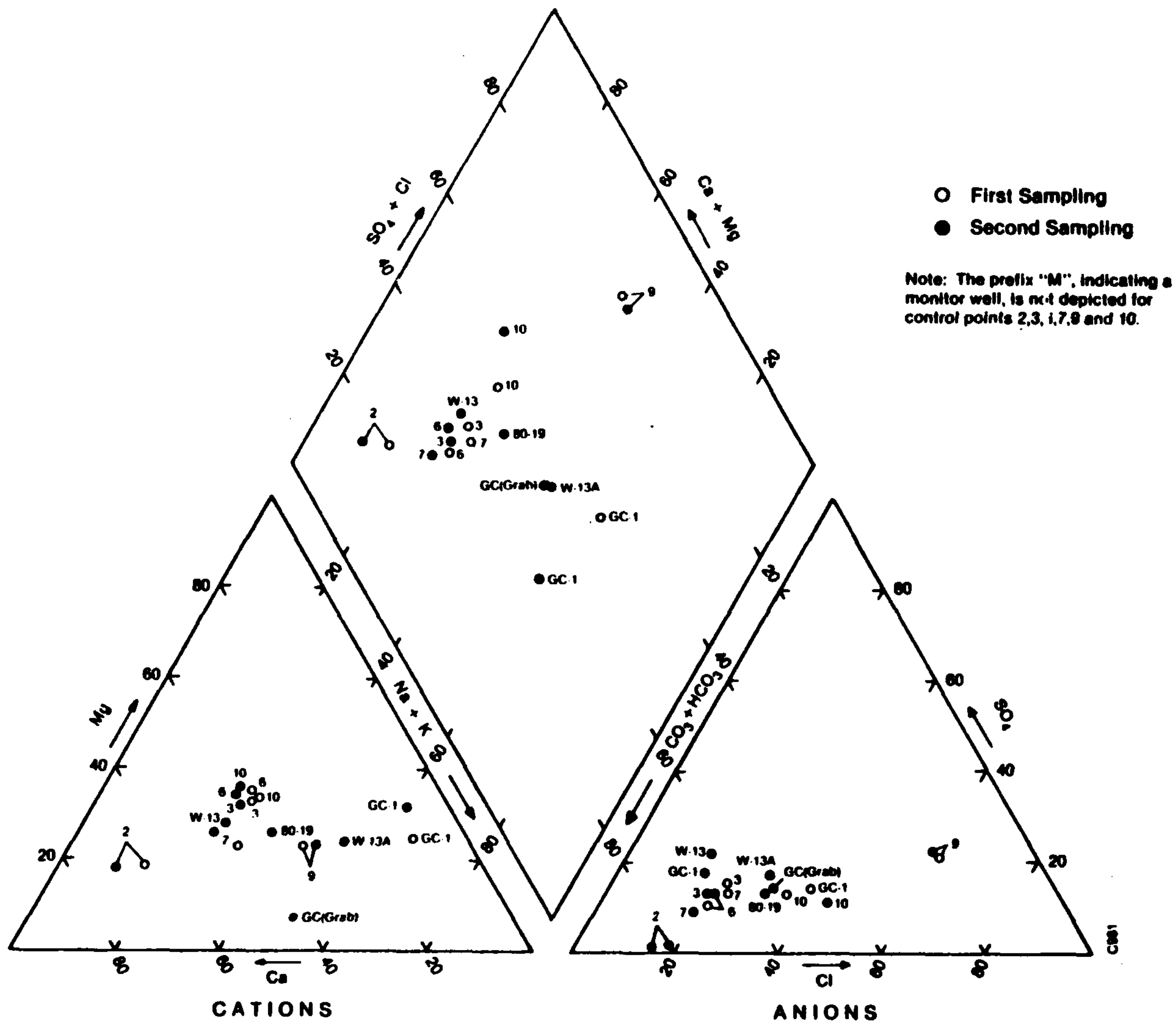

Figure 4-6. Golf Course Study Trilinear Piper Diagram

Groundwater in the shallow and lower aquifers appears to be essentially the same as evidenced by the common grouping of water from wells in both zones on the diagram. This further indicates hydraulic connection and common recharge sources for the two aquifers.

The investigation at the Golf Course reliably demonstrates that groundwater exists there. The chemical analysis indicates the probability of Golf Course groundwater recharge to the lower waste areas, and possibly to other areas of the base. The exact nature is not reliably known based upon the present data base. Two additional benefits of conducting the study were first, identifying two monitor wells (M-2, M-9) which appear chemically different from the other monitor wells suggesting waste site impacts and secondly, the upper and lower aquifer groundwaters appear the same with probable common recharge areas. Furthermore, static water level data suggest hydraulic connections between the aquifers at the Golf Course and the aquifer encountered at Berman Pond (BPM-2). Additional discussion of the chemical analyses are in subsection 4.1.3.3.

4.1.3.3 Chemical Analyses and Reliability. The detailed results of the analyses of the first round of water samples from the Golf Course Area (Well GC-1) are presented in Appendix Table F-4. Analyses for a set of water quality parameters (iron, manganese, calcium, magnesium, sodium, potassium, carbonate, bicarbonate, chloride, fluoride, nitrate, hardness and silica) were performed to assess the effect of recharge from the Golf Course Area upon Chemical Disposal Pits No. 1 & 2 and Landfill No. 3. The detailed results of screening analyses by ICP and GC/MS for Well GC-1 are presented in Appendix Tables F-7 (ICP) and F-9 (GC/MS). As a result of the screening analyses, the following parameters were added to the list of analyses for the second round of sampling: barium and zinc.

The detailed results of the analyses of the second round of water samples from the Golf Course Area (Well GC-1, existing wells 80-19 and W-13 plus a grab sample of parking lot runoff) are presented in Appendix Table F-14.

A summary of the analyses of water samples is contained in Table 4-5.

Table 4-5

Summary of Water Sample Analyses and Organic Compounds Detected in Groundwater for Golf Course Area

Analysis	Units	GC-1	80-19*	W-13*	W-13A*	(Grab) Parking Lot Runoff
TOC	mg/L	2-3				
TOX	μg/L	70				
O&G	mg/L	<5-6				
Phenol	μg/L	70-390				
MBAS	mg/L	<0.1-0.2				
TDS	mg/L	620-1,000	730	630	1,000	80
Cyanide	μg/L	<10				
Sulfate	mg/L	88-110	75	110	130	8
Arsenic	μg/L	<5-<10				
Barium	μg/L	<100	<100	<100	<100	<100
Beryllium	μg/L	<10				
Cadmium	μg/L	<10	<10	<10	<10	
Chromium	μg/L	<50				
Copper	μg/L	<20				
Iron	μg/L	<100	<100	<100	<100	200
Lead	μg/L	<10-<20				
Manganese	μg/L	250-440	<20	360	270	<20
Mercury	μg/L	<0.2-<10				
Zinc	μg/L	50	230	100	30	50
Conductance	μmho/cm	900-1,800	1,000	920	1,500	100
Calcium	mg/L	20-32	97	100	84	10
Magnesium	mg/L	43-46	42	37	51	1
Sodium	mg/L	140-210	110	66	200	13
Potassium	mg/L	24-26	6	6	10	<1
Carbonate	mg/L	30-52	23	16	28	10
Bicarbonate	mg/L	320-410	360	360	470	20
Chloride	mg/L	66-230	130	60	170	14
Fluoride	mg/L	1.0-1.3	0.5	0.5	0.7	0.2
Nitrate	mg/L	2.0-5.4	2.8	0.5	2.7	0.57
Hardness	mg/L	230-270	420	400	420	29
Silica	mg/L	5-6	14	16	16	2

EPA 602						
Ethyl benzene	μg/L	<1-3				

* Monitor wells located topographically downslope from Well GC-1.

Table 4-5 (continued)

(micrograms per liter)

	Detection Limit	GC-1
GC/MS		
Base/Neutral Extractable Compound		
Diethyl phthalate	1	[illegible]
Di-n-butyl phthalate	1	3
Bis(2-ethylhexyl)phthalate	1	3
GC/MS		
Additional Base/Neutral Compounds		
2,2,4-Trimethyl-1,3-pentane diol-di-isobutyrate		5-20
Tris-2-butoxyethyl phosphate		5-20
Caprolactam		12-50
2-Butoxyethanol		2-8
Benzothiazole		2-8
An Amine MW=171		1-4
Hexadecanoic acid		2-6
Alkyl benzenes		4-16
Hexadecane		2-6
Octadecane		0.5-2
Nonadecane		1-4
Eicosane		1-4
Heneicosane		0.5-2
Phytane		0.5-2
Paraffin oil C_{20}-C_{40}		250-1000
ICP Analysis	(milligrams per liter)	
Sodium	1.3	310
Potassium	2.5	38
Calcium	0.3	41
Magnesium	0.5	74
Silicon	0.3	4.0
Strontium	0.02	0.2
Manganese	0.3	0.7
Zinc	0.2	0.6
Lithium	0.05	0.1
Boron	0.2	0.5

As noted in Section 3.5, the water sample analyses were reliable subject to the limitations noted for the TOX analysis and EPA Method 602.

4.1.4 Berman Pond

4.1.4.1 Geophysics Results and Reliability.

4.1.4.1.1 Geophysical Results. This area is located immediately east of the visitor center at the south entrance to the base. The site has been filled and graded. Initially it consisted of an unlined evaporation pond for industrial waste waters and electroplating wastes. It was also used as a dumping site for old wheel rims, barrels, concrete with steel reinforcing, etc. A depression located in a small clump of trees shows exposed metal trash beneath about 2-3 feet of soil backfill.

Electrical Resistivity Survey. Four dipole-dipole lines, each consisting of several 7-spreads, were completed across the dump area using 30-foot dipole spacings (Figure G18). All lines are oriented north-south. Line 1 is located 100 feet east of the chainlink fence surrounding the visitor center. The original centers (station 0) for lines 1-3 are positioned 120 feet south of the oiled road leading to Foulois Drive. These lines in turn are 90 feet apart. Line 4 is located 85 feet east of Foulois Drive and centered 95 feet south of the oiled road leading to the Hanger area as shown in Figure G19.

Figures G19 to G22 show the observed apparent resistivity data. Station 0 on each of the four lines appears to be nearly centered in the Berman Pond fill. Apparent resistivity values less than 100 ohm-meters are thought to generally outline the filled area. Line 1 (Figure G19) appears to have crossed the western edge of the old pond area. Apparent resistivities less than 100 ohm-meters extend from about station 6N to 2S. These lower resistivities are fairly shallow (0 to 30 feet) hence the conclusion for being over the edge of the old pond. To the south of station 2S, the apparent resistivities increase abruptly to over 200 ohm-meters and suggest this portion of the line is relatively undisturbed from its original state.

Line 2 (Figure G20) shows apparent resistivities less than 100 ohm-meters extending between stations 6N and 2S. These are evident to a

greater sounding depth than on Line 1 and indicate a greater thickness of the fill in the old pond. Although the apparent resistivity values between stations 2S and 8S are in excess of 100 ohm-meters, they are also very erratic. This area is undoubtedly part of the landfill. As previously mentioned, there is a small depression directly west of stations 6 and 7S which shows exposed metal trash beneath about 3 feet of soil. There are surface indications of an old dike between stations 8 to 10S. This dike has since been greatly subdued with passing time and weather. However it is not until this dike is encountered (Sta. 8S) and passed, that the observed apparent resistivity values have become uniform enough, with high apparent resistivities (400-900 ohm-m) to suggest undisturbed ground.

Line 3 (Fig. G21) shows apparent resistivities less than 100 ohm-meters extending between stations 6N and 4S. These extend downward to the limit of detectability with the 30-foot dipole spacing. This line would therefore appear to be over the deeper portions of the old pond. South from about station 6S the observed apparent resistivities suggest undisturbed ground.

Line 4 (Fig. G22) shows the lower observed apparent resistivities to extend northward from station 2S to at least station 7N. This appears to encompass a portion of the old pond. Southward the resistivities are fairly uniform and suggest a layering of at least two distinctive units with the resistive unit lapping onto the more conductive underlayer.

Numerical models were computed for Lines 1 and 3. There are shown as Figures G23 and G24 respectively and in general show an outline of the inferred old pond boundaries in a north-south and vertical sense. It is not clear from the models if the old pond was actually as deep as is inferred. Perhaps downward percolating chemical wastes have left a residue behind that has lowered the apparent resistivity within the pond area giving the apparent large depth shown by the models.

It also appears from the observed apparent resistivity data (Figures G19-G22) that a thick (greater than 5 feet) laterally extensive clay layer is present within 60-90 feet of the surface beneath the southern end of

the area surveyed at Berman Pond. The decrease in apparent resistivity with depth shown for the lines can only be explained by a conductive media such as a clay layer. This conductive layer appears to be dipping to the south and may as a result occur at a shallower depth near the southern limit of the old pond area.

Ground Magnetic Survey. Because of the metal waste discarded in the old pond, it was decided to conduct a ground magnetic survey over the same general area as that covered by the electrical resistivity survey. Hopefully, enough iron would have been discarded to produce magnetic anomalies that in turn would be helpful in delineating the boundaries to the old pond area.

Figure G25 shows contoured results from 760 stations spaced 5 and 10 feet apart. It is obvious from the data shown that a significant amount of iron waste such as wheel rims, barrels, and steel reinforcing in concrete has been discarded in the old pond area. Numerous small magnetic anomalies are evident. Furthermore it is possible to outline, in part, the southern and southwestern boundary to the filled area. The buildings and metal fences north and west of the filled pond make it impractical to define the boundaries in those directions with an acceptable degree of accuracy.

4.1.4.1.2 Reliability of Geophysical Results. The electrical resistivity survey has clearly shown significant differences in apparent resistivity between undisturbed ground and the filled-in old pond area. Each of the four lines surveyed also show a deep clay layer on the southern end of the area. This layer appears to vary in depth, increasing to the south. No numerical models were computed outside the old pond area hence depths to this deep clay layer are not well known at this time.

The ground magnetic data are very uniform in the area outside the old pond area and are repeatable to within five gammas. The data over the filled-in pond are much more erratic because of the discarded iron in the fill. However, because of this it is possible to identify the southern and southwest edge of the old pond reasonably well.

4.1.4.2 Field Investigation Results and Reliability.

4.1.4.2.1 Groundwater Impact. The reason for the investigation of Berman Pond was to determine the potential for the site to contaminate any local groundwater systems. As an aid to determine the pond's impact on the subsurface, two monitor wells and four lysimeters were emplaced in order to obtain soil and groundwater samples for chemical analysis. The results of the chemical analyses do not conclusively show the presence of contamination attributable to Berman Pond. Figure 4-7 shows the results of analyses for TOC and TOX which were selected as site-specific examples. There are several possible reasons for the inconclusive detection of contamination from Berman Pond. These are discussed below.

4.1.4.2.2 Hydrogeologic Conditions. The hydrogeologic data collected at Berman Pond indicate that fine sands and silts occur directly beneath the pond with various clay horizons beginning at about 20 feet. Generally, liquid contamination or leachate will flow downward under a disposal site until it reaches a saturated zone or an impermeable boundary such as clay. Upon reaching this zone it will then flow laterally along this boundary. The clays as determined by soil borings and geophysics were found to be discontinuous and nonuniform under the site (Figure 2-11). No perched groundwater was encountered. Therefore, the lysimeters and monitor wells may have not intercepted possible zone(s) of contamination.

4.1.4.2.3 Disposal Practices at Berman Pond. The historical disposal practices at the site indicate that leachate or infiltration rates during its operations may have been stabilized or reduced by several physical factors. First, the existence of a "filter cake" along the bottom of the pond, was observed during excavation for the replacement of an old storm drain line on the north side of Berman Pond (Vining, 1982; Davis, 1982). Filter cakes are generally characterized by low permeabilities relative to the underlying natural material. During the excavation soil sample were sent by the Hill AFB Bioenviromental Engineer's office to the Directorate of Maintenance Chemical Laboratory for analysis. No cyanides, chromates or phenols were noted (Gaudet, 1982).

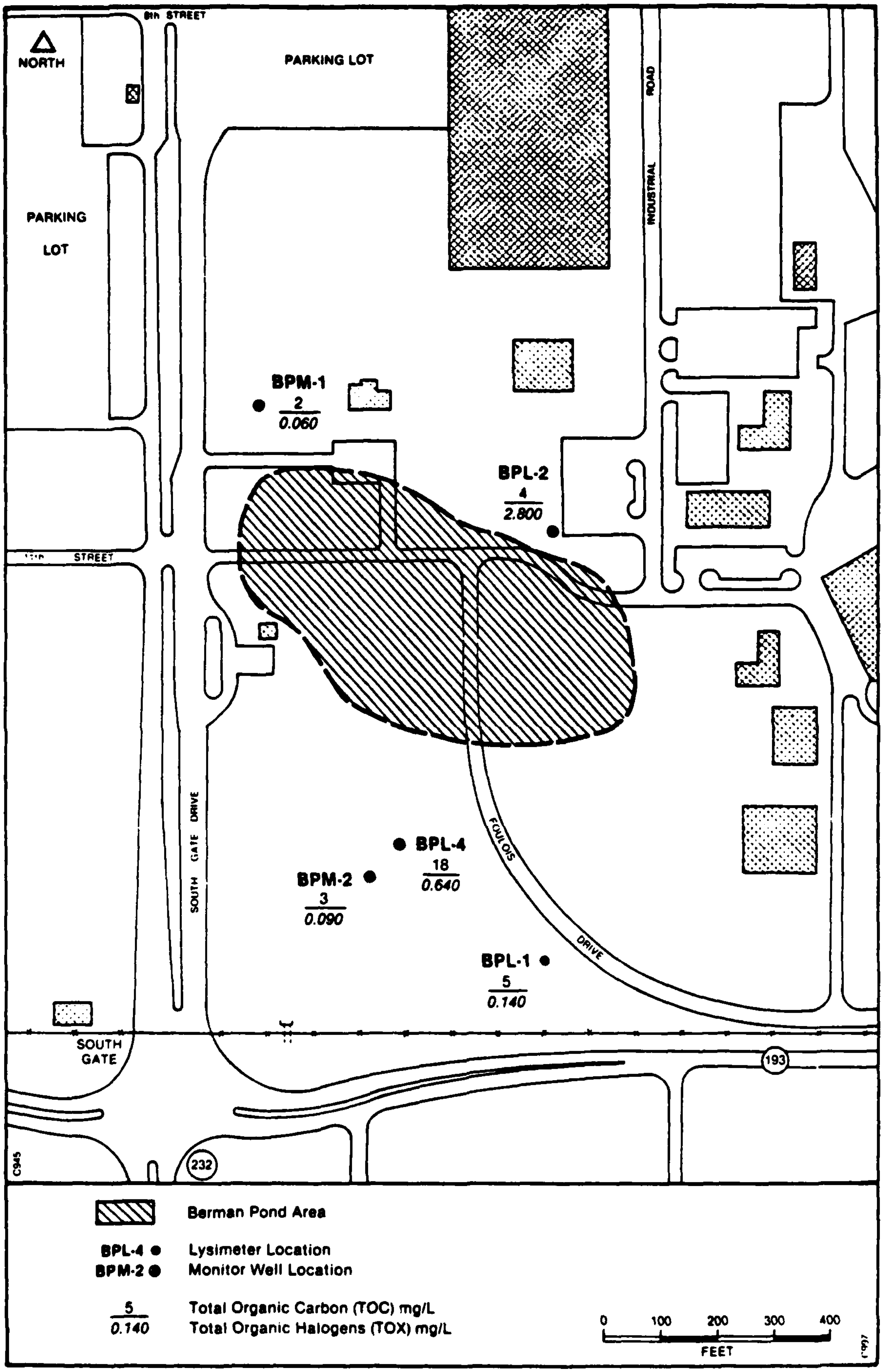

Figure 4-7. Selected Ground Water Quality Indicators at Berman Pond.

The data review process revealed that an old, approximately 12-inch cast iron sanitary sewer line originated from Berman Pond and connected with the main base sewer line. The sewer was connected to a drain system that would periodically, as the fluid level rose to a predetermined height, in the pond, permit fluids to flow into the sanitary sewer line (Harvey, 1982). The net effect of this system would be to maintain hydraulic heads at or below specified levels and to reduce the volume of leachate that could pass through the pond bottom.

It was also found that during the closure, the pond (in the late 1950's) was filled with excavation rubble. An overflow system appears to have been temporarily constructed to prevent excess fluids from spilling over the sides of the pond during closure. This trench went from the pond along south Gate Drive to a storm drain system near the south gate shown on Figure 4-8 (Taylor, 1983).

The possible result of these factors would be to reduce the free fluids in the pond because the construction rubble (i.e., concrete blocks, steel reinforcing, dirt) would tend to displace the fluids into the overflow trench and away from the site through the drain system. This would result in fewer fluids available for leachate generation although the soil component could still absorb fluids. Leachate generation would then be more a function of external water availability either through local precipitation or possible leakage from base utility water and waste water lines. The filter cake that lines the bottom of the pond would tend to slow or stop leachate from exfiltrating the pond.

This same filter cake could create a "bathtub effect" in the pond if precipitation percolated through the cover and fill material and its downward migration was slowed or halted at the filter cake. Water was noted at about 12 feet in the fill when the Base civil engineers were replacing an old drain line on the north side of the pond (Vining, 1982). The source of the water is not exactly known but could be past water leakage from the old drain line and/or precipitation infiltration. These various factors and those mentioned previously would all influence the chemical analysis of soil and groundwater in the vicinity of the pond's subsurface.

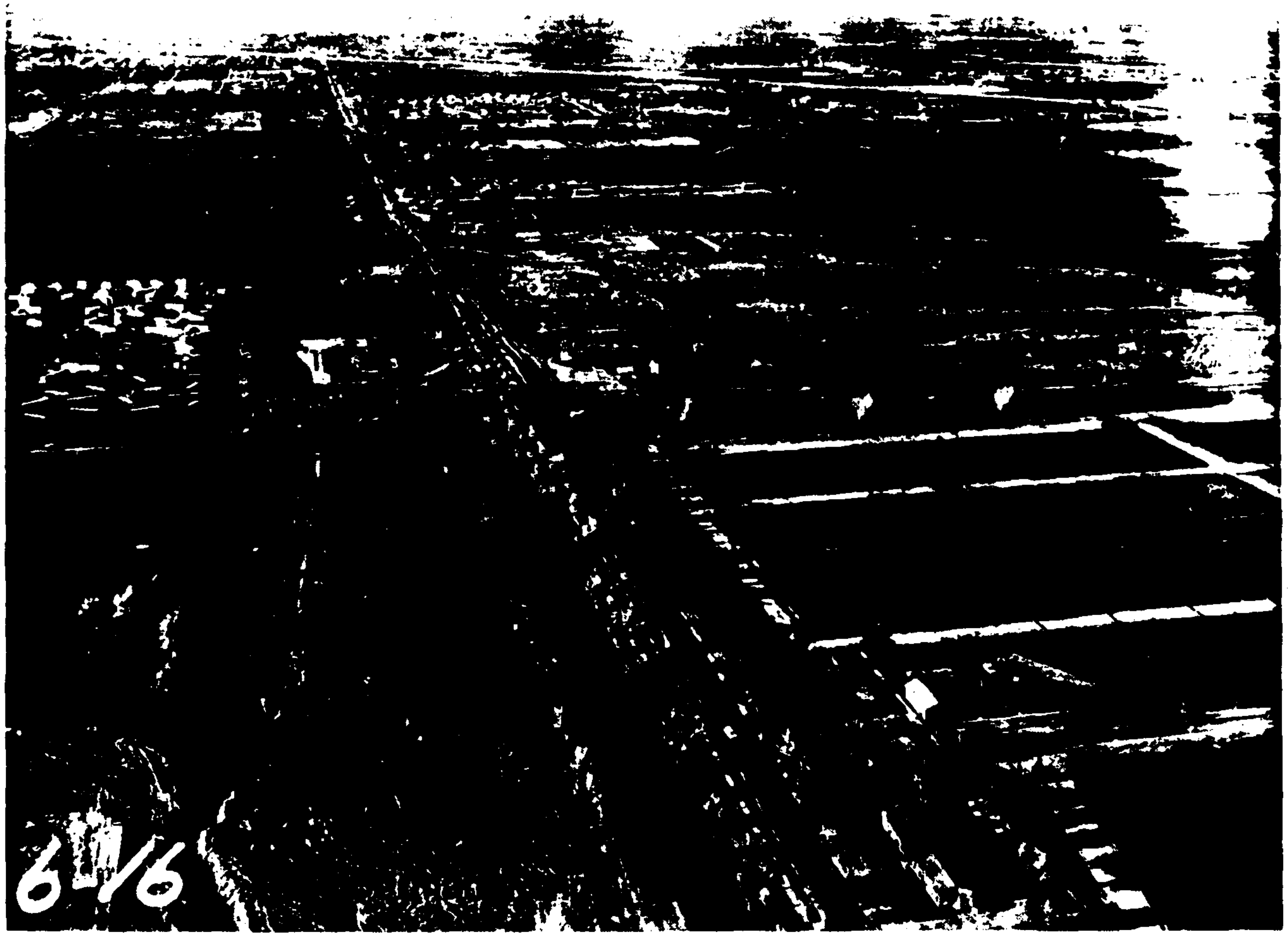

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Figure 4-8. Berman Pond and Drainage Trench.

A small section of the final pond fill or cover was observed in a small excavation several feet deep near the intersection of 11th Street and Foulois Drive. The fill or cover material was observed to be large gravels, sands and silts. An inhomogeneous cover such as this will generally have less porosity and permeability than the more uniform natural sands around the pond area (Meinzer, 1923).

The soil moisture and groundwater chemical analyses were not conclusive as to the presence of contamination specifically attributable to Berman Pond. Also, any constituents that might appear abnormal could be influenced by the various factors described above. For instance, if any of the utility lines leak(ed) the chemical anlysis could reflect either leachate from Berman Pond or components from the utility line. This is especially pertinent to storm and IWTP water drain lines. The chemical and hydrogeologic data are felt to be representative only of the subsurface conditions in their immediate vicinity. Based upon the present data, leachate and/or contaminant migration from Berman Pond specifically cannot be reliably assessed. Further discussion of the chemical analyses will be addressed in subsection 4.1.4.3 and Section 4.2.

4.1.4.3 Chemical Analyses and Reliability.

4.1.4.3.1 Chemical Analyses. The results of the analyses of soil samples from Berman Pond are presented in Appendix Table F-2 and in Table 4-6.

The detailed results of the analyses of the first round of water samples from the wells (BPM-1 and BPM-2) and the lysimeters (BPL-1 through BPL-4) are presented in Appendix Table F-5.

The results of the screening analyses by ICP and GC/MS for monitor wells BPM-1 and BPM-2 are presented in Appendix Table F-8 (ICP) and Appendix Table F-10 (GC/MS). As a result of the screening analyses, the following parameters were added to the list of analyses for the second round of sampling: barium, iron, manganese, zinc, calcium and magnesium. A conductivity test was added to the lysimeter sample analyses.

Table 4-6

Summary of Soil Sample Analyses for Berman Pond (Fall 1982)

Analysis	Units	BP28A	BP28B	BP58A	BP58B	BP58C	BP75A	BP75B	BP77A	BP77B	BP111A	BP111B	BP11	BP15	BP17	BP38	BP110	BP311
TOC	µg/g	940	1000	1300	4200	650	680	990	630	900	1500	690	6000	2200	1100	630	2100	1300
TOX	µg/g	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<6	<5
O & G	mg/g	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	12	<5	<5	<5	<6	<5
Phenol	µg/g	<11	<11	43	<10	<10	<11	<10	<11	<10	<11	<10	<11	<11	<10	<10	<11	<10
Cyanide	µg/g	<11	<11	<11	<10	<10	<11	<10	<11	<10	<11	<10	<11	<11	<10	<10	<11	<10
Beryllium	µg/g	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Cadmium	µg/g	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	17	<4	<4	<4	<4	<4
Chromium	µg/g	<21	<21	<22	<20	<20	<21	<21	<21	<21	<21	<21	230	<22	<20	<21	<22	<21
Moisture	%	5.5	6.3	7.3	2.4	2.1	5.9	2.9	5.4	4.5	6.7	4.0	7.4	8.6	2.1	3.5	9.1	4.5

Note: Results have been corrected for % moisture.

The detailed results of the analyses of the second round of water samples from Berman Pond are presented in Appendix Table F-15.

The results of the water sampling are summarized in Table 4-7.

4.1.4.3.2 Reliability. As noted in Section 3.5, the soil analyses were sufficiently reliable to assist in location of the disposal site. The water analyses were generally reliable. The problems with the analysis for volatile aromatics by EPA Method 602 and with the TOX analysis have been discussed above in Section 4.1.1.3.2. It should be noted that the analytical results for volatile components (EPA Methods 601 and 602) in lysimeter samples may be low because the samples were collected under vacuum.

4.1.5 Chemical Disposal Pit No. 3

4.1.5.1 Geophysical Results and Reliability.

4.1.5.1.1 Geophysical Results. Chemical Disposal Pit No. 3 is located along the eastern border of Hill AFB and is approximately 200 feet inside the boundary fence. Two buildings, 10779 and 768, are located on top of the Weber Delta west and southwest of the pit area. Two parallel trenches approximately 70 x 5 x 3 feet and trending N25°W are evident and appear to be remnants of the old disposal pits. It is important to note that these trenches are cut in the top of an old slump block that has broken away from the Weber Delta.

Electrical Resistivity Survey. Five dipole-dipole lines using 30-foot dipole spacings were completed over the disposal area (Figure G1). Line 2 trends N25°W parallel to the trenches. The remaining four lines trend N65°E normal to and across the trenches. All of the dipole-dipole lines were within the boundary fence.

Figures G2 to G6 show observed apparent resistivities along the five lines. These data show the area to be structually very complex. Apparent resistivities vary between 10 ohm-meters and 760 ohm-meters. The higher apparent resistivities, where present, occur at the shallower depths. The lower apparent resistivities occur primarily at greater depths but there are areas where these also occur at or near the surface.

Table 4-7

Summary of Water Sample Analyses and Organic Compounds Detected in Ground and Soil Water for Berman Pond

Analysis	Units	BPM-1	BPM-2	BPL-1	BPL-2	BPL-3	BPL-4
TOC	mg/L	2-4	2-3	5-6	4	*	14-18
TOX	µg/L	60	90	140	2,800	*	640
O&G	mg/L	<5	<5	*	<5	*	*
Phenol	µg/L	<10-30	10-20	10	<10	*	*
Cyanide	µg/L	<10	<10	*	<10	*	*
Barium	µg/L	<100	<100	<100	<100	*	<100
Beryllium	µg/L	<10	<10	<10	<10	*	<10
Cadmium	µg/L	<10	<10	<10	<10	*	<10
Chromium	µg/L	<50	<50	<50	<50	*	<50
Iron	µg/L	<100	<100	<100	<100	*	<100
Manganese	µg/L	50	70	<20	<20	*	<20
Zinc	µg/L	<10	<10	30	<10	*	40
Conductance	µmho/cm	250-400	450-840	460	530	*	640
Calcium	mg/L	18	25	77	100	*	110
Magnesium	mg/L	11	8	9	7	*	14

Analysis EPA 601	Units	BPM-1	BPM-2	BPL-1	BPL-2	BPL-3	BLP-4
1,1,1-Trichloroethane	µg/L		4-13	160	1-3	*	4
Carbon Tetrachloride	µg/L			1		*	
Trichloroethylene	µg/L		5	1,400	2-6	*	3
1,1-Dichloroethene	µg/L		2	59		*	
1,1-Dichloroethane	µg/L		12			*	
Tetrachloroethene	µg/L			200		*	
Chlorobenzene	µg/L	4	2-11	2	3	*	
1,2-Dichlorobenzene	µg/L	4	38			*	
EPA 602							
Toluene	µg/L			1-2	1	*	*
Ethyl benzene	µg/L		3	1	2	*	*
Xylenes	µg/L		21		2	*	*

"*"Denotes a sample which could not be collected

Table 4-7 (continued)

(micrograms per liter)

GC/MS Purgeable Compounds	Detection Limit	BPM-1	BPM-2
1,1-Dichloroethane	8		13
1,1,1-Trichloroethane	8		15
GC/MS Additional Purgeable Compounds			
Dichlorobenzenes	8		15-60
GC/MS Base/Neutral Extractable Compounds			
1,3-Dichlorobenzene	1		1
1,4-Dichlorobenzene	1		16
1,2-Dichlorobenzene	1		2
1,2,4-Trichlorobenzene	1		2
Bis(2-ethylhexyl)phthalate	1	16	3
Di-n-butyl phthalate	1	2	1
Di-n-octyl phthalate	3	3	4
GC/MS Additional Base/Neutral Compounds			
2,2,4-Trimethyl-1,3-pentane diol-di-isobutyrate		5-20	1-4
Tris-2-butoxyethyl phosphate		3-12	3-10
Caprolactam		10-40	4-14
$C_5H_8Cl_2$		1-4	
2-Ethylhexanoic acid		7-28	2-6
Hexadecanoic acid		1-4	
Xylenes		5-20	
Decane		1-4	
Hexadecane		1-4	
Heptadecane		0.5-2	
Pristane		0.5-2	
Octadecane		1-4	
Phytane		0.5-2	
Nonadecane		2-6	
Eicosane		1-4	
Heneicosane		1-4	
Paraffin oil		150-700	
GC/MS Acid Extractable Compounds			
Phenol	1	1	1
GC/MS Additional Acid Compounds			
1,1,3,3-Tetramethylbutylphenol (or similar)			2-8

Table 4-7

(milligrams per liter)

ICP Analysis	Detection Limit	BPM-1	BPM-2
Sodium	1.3	34	87
Potassium	2.5	4.4	3.6
Calcium	0.3	19	74
Magnesium	0.5	8.6	13
Silicon	0.3	0.4	5.2
Strontium	0.02	0.08	0.19
Barium	0.6		0.6
Manganese	0.3		0.7
Zinc	0.2		0.7

Numerical model results are presented as Figures G7 to G11. The numerical models for the four N65°E lines all show that the area within the station intervals 2SE to 5NE is quite complex. This is interpreted as due to multiple slumped features within the larger slump block. The area covered by the lines south of station 2SE is much more uniform and apparently represents the general layering of the Weber Delta where undisturbed. Line 2 which is parallel to the trenches confirms the resistive nature of the slump block as shown by the other four lines. Line 2 does not appear as complex within the slump area primarily because of the line orientation which is approximately parallel to the slide plane of the slump as opposed to crossing it as is the case with the other four lines.

It is important to identify underlying clay layers within the disposal area, if at all possible. A clay layer would conceivably form an impervious layer through which the chemical wastes would not migrate. Because clay tends to be conductive, the low apparent resistivity values shown on the numerical models are likely to be indictative of a clay layer. Figures G12 to G14 are section views showing interpreted locations of major clay layers within the disposal area as derived from the numerical models. Note that the clay layer present at depth on the southwest end of the disposal area does not continue through the slump area. While small pockets of clay exist within the disturbed area of the slump, these are not likely to be much of a restraint to downward moving chemical wastes. Two other Figures, G15 and G16, are plan views of apparent resistivity determined from the numerical models and presented as slices of the electrical resistivity distribution for depth intervals of 18-30 feet and 45-60 feet respectively. These figures show the general outline of the resistive slump area and the extent of the conductive clay layer within the chemical disposal area.

Self-Potential Survey. A self-potential survey has also been completed at Chemical Disposal Pit No. 3. This survey consists of traverses along the existing apparent resistivity lines using a 10-foot station interval. This geophysical method was employed in an attempt to gain a better understanding of fluid movement or perhaps residual

concentrations of the chemical wastes within the disposal area. In general, natural electrical potentials are created by fluid streaming, bioelectric activity in vegetation, varying electrolytic concentrations in groundwater and other geochemical action (Telford et al., 1976). Ideally, self-potential anomalies could be mapped within the disposal area and these could be attributed to residues left in the ground as a result of the dumped chemicals.

Figure G17 is a presentation of the results of the SP survey. Basically no significant anomaly occurs that can be attributed to chemical residuals within the soils. The negative effects along the southwest and southeast edges of the survey are streaming potentials caused by water moving from higher to lower elevations near the exposed face of the slump. The majority of the area surveyed shows the potentials to be fairly uniform. The elongated zone of negative potentials occurring between the disposal pits and the perimeter road is thought to result from fluids leaving the relatively flat surface at the top of the slump block in order to migrate farther downslope. The edge of the slump occurs along the eastern edge of the road.

4.1.5.1.2 Reliability of Geophysical Results. The electrical resistivity survey has shown the area of Chemical Disposal Pit No. 3 to be very complex. The use of two-dimensional numerical models has given some indication of this complexity. The refinement of the understanding of the area's physical complexity can only be achieved through drilling.

The self-potential survey data were obtained along traverses. These traverses were "closed" by tieing back to the base station. Drift did not exceed 5.1 millivolts.

4.1.5.2 Field Investigation Results and Reliability. Chemical Disposal Pit No. 3 was investigated to identify and locate the disposal pit, determine its impact on the local groundwater system and assess the potential for off-base migration. The result of this field effort has clarified all three items of interest.

The results of this IRP Phase II field investigation and data review (Pashley, 1971; Sibbett, 1982) of Chemical Disposal Pit No. 3 indicate

that the site is located on top of a hydrogeologically complex slump feature(s) as discussed in Section 2.0. The complexity of the site made interpretation of the field data difficult for the hydrogeologic and geophysical survey investigations.

4.1.5.2.1 Pit Delineation. The site was located through personal communication (Goodrich, 1982), aerial photography (Ross, 1982) and confirmation soil borings. The results indicated that the "pit" presently consists of two trenches (Figure 2-13). The two trenches and the results of the soil borings are shown on Figure 4-9. Note the one auger location on the southwest side of the fault where solvents were encountered was a deeper boring using a hollow-stem auger. There was little surface evidence to suggest a solvent source. The results of the chemical analyses of the groundwater obtained at the site indicate the presence of solvents in the groundwater. Trichloroethylene (TCE) was selected as a site-specific indicator parameter for the site since it was found in higher concentrations than the other solvents found. Sampling locations and observed concentrations (Figure 4-10) appear to correlate with the sampling point location relative to the source and the nature of the local formation permeability. The largest concentrations occur within piezometers P-6 and P-10 at the pits proper. Piezometer P-7, which indicates a high level of solvent, is located hydraulically and structurally upgradient and on the west side of the fault (Figure 2-16; cross Section C-B'). This indicates that there may be either another pit(s) and/or a different source of solvent, neither of which were previously known. Another possibility is a natural cyclical recharge/discharge storage system.

In addition to the fault shown on Figure 4-10, the geophysical surveys indicate possible slump faults further up the hill to the west of the waste pit. Other slump faults and slip planes are likely to exist throughout this entire area.

4.1.5.2.2 Slump Delineation. U.S. Air Force personnel provided topographic survey of selected control points east of the base boundary down to the Davis-Weber Canal. The survey was an aid to identify the likely downslope areas for solvents migration and the possible

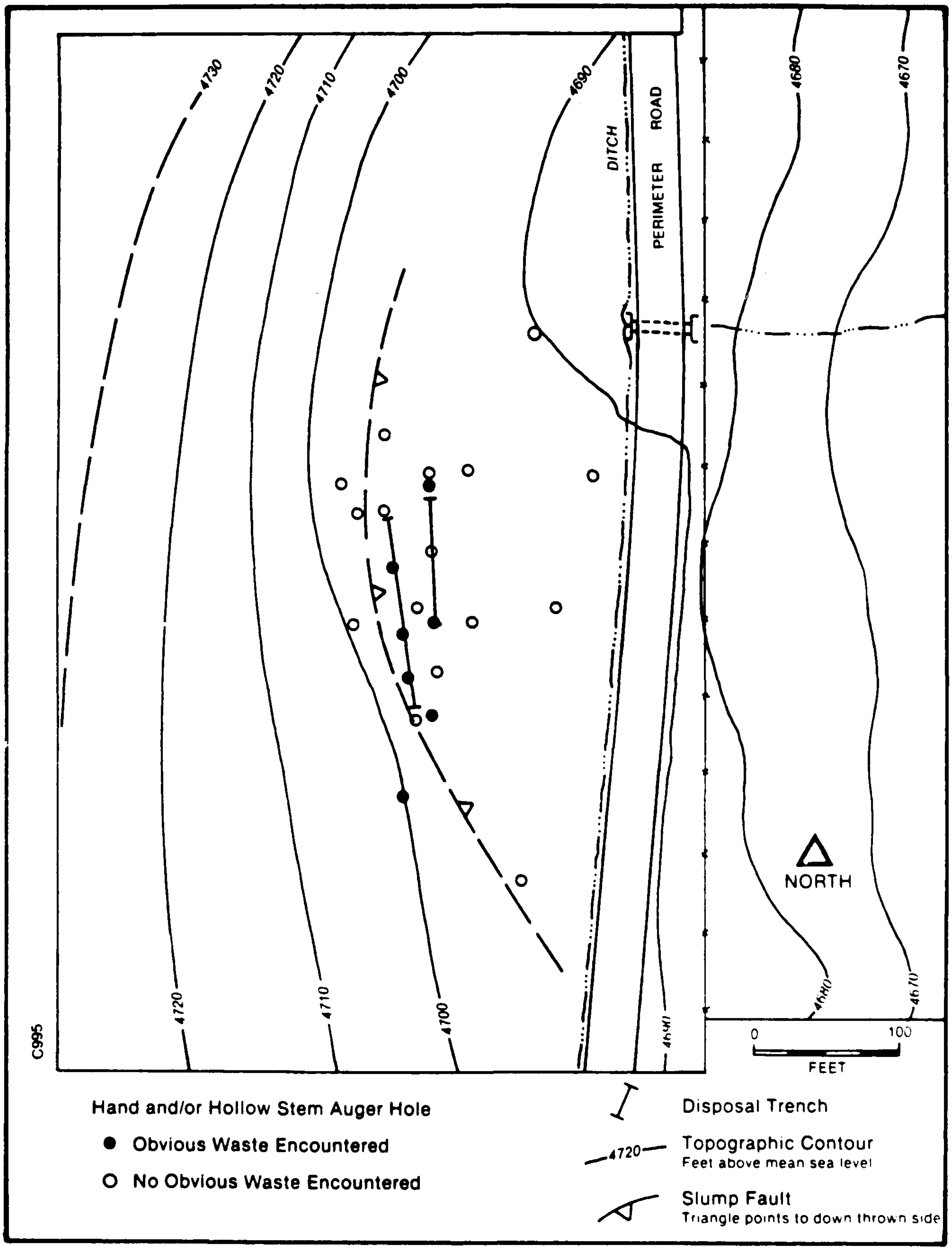

Figure 4-9. Results of Coring, Chemical Disposal Pit No. 3.

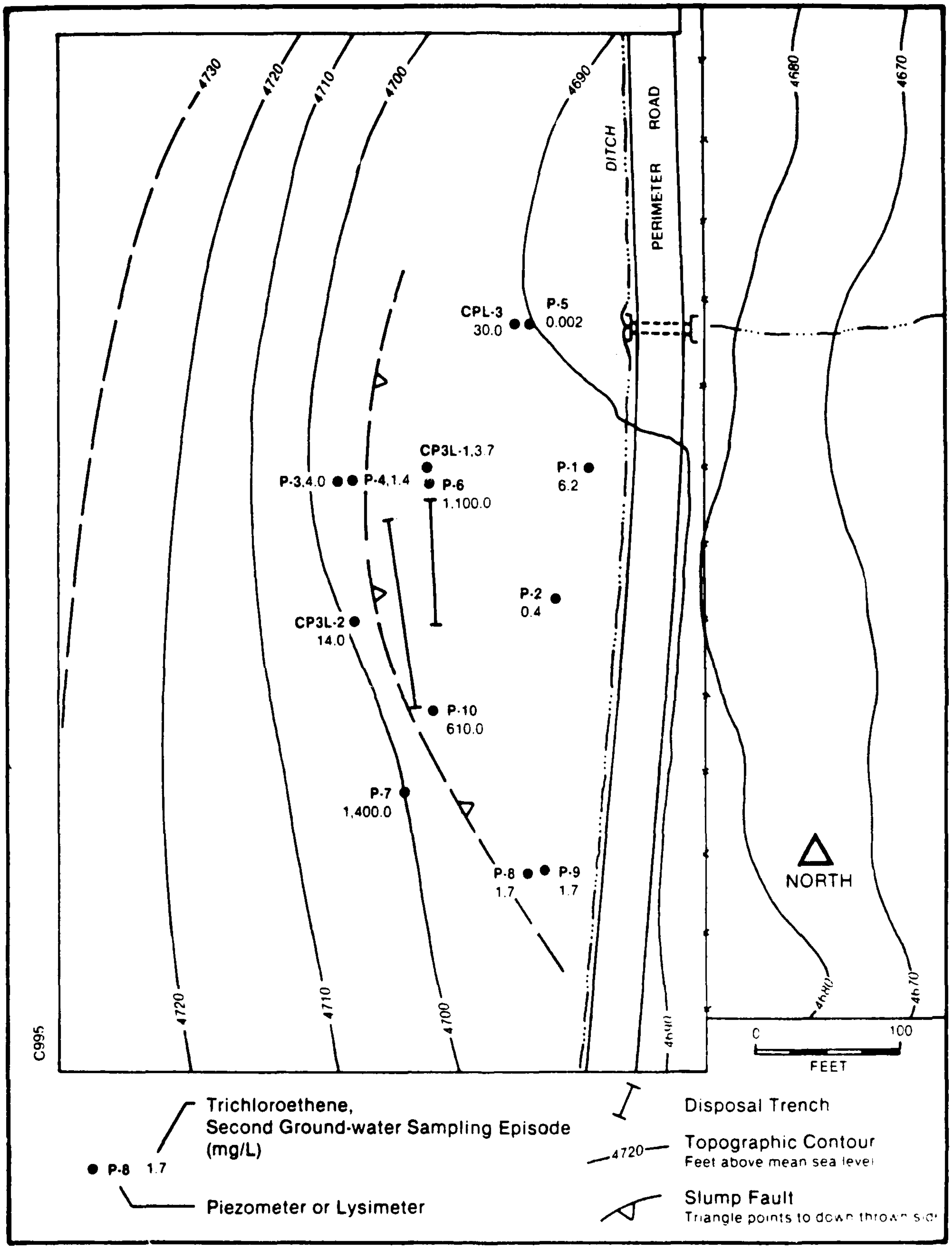

Figure 4-10. Trichloroethylene in Ground Water at Chemical Disposal Pit No. 3

configuration of the slump. The resulting topographic contours are depicted on Figure 4-11 which is estimated to bracket the north and south extent of the slump of interest. Further detailed studies off-base at Chemical Disposal Pit No. 3 and potentially in the area east of the Davis Weber canal will be needed to fully characterize the site. Assuming that the area shown is the extent of the hydraulic system of the slump then that area noted would be expected to encompass the possible lateral limits of solvent migration. The east-west cluster of trees on the south side and the intermittent drainage on the north side may well reflect the lateral areas of slippage from the slump.

The intermittent drainage in the middle and downslope from the drainage culvert under the Perimeter Road may be a minor slip plane. However, it is more likely related to surface water flows from the uphill drainage areas west and south of the Perimeter Road which pass through the culvert under the road (Figure 4-11). Solvents flowing at or near the surface as well as leachate could have exited from the disposal pit via this culvert or possibly along the old topographic surface under the Perimeter Road (Figure 2-15).

This site investigation resulted in the locating of the disposal pit and establishing the presence of solvents in the groundwater. Also, an additional unknown source of solvents is suspected south or southwest of the known disposal pit. Additional results of the chemical analyses will be addressed in sections 4.1.5.3 and 4.2.

4.1.5.3 Chemical Analyses and Reliability.

4.1.5.3.1 Chemical Analyses. The results of the analyses of soil samples from Chemical Disposal Pit No. 3 are presented in Appendix Table F-3 and Table 4-8.

The detailed results of the analyses of the first round of water samples from the piezometers (P-1 through P-10) and the lysimeters (CP3L-1 through CP3L-3) are presented in Appendix Table F-6.

No screening analyses were performed at Chemical Disposal Pit No. 3. However, as a result of the ICP and GC/MS screens performed at the other sites, the following parameters were added to the list of analyses

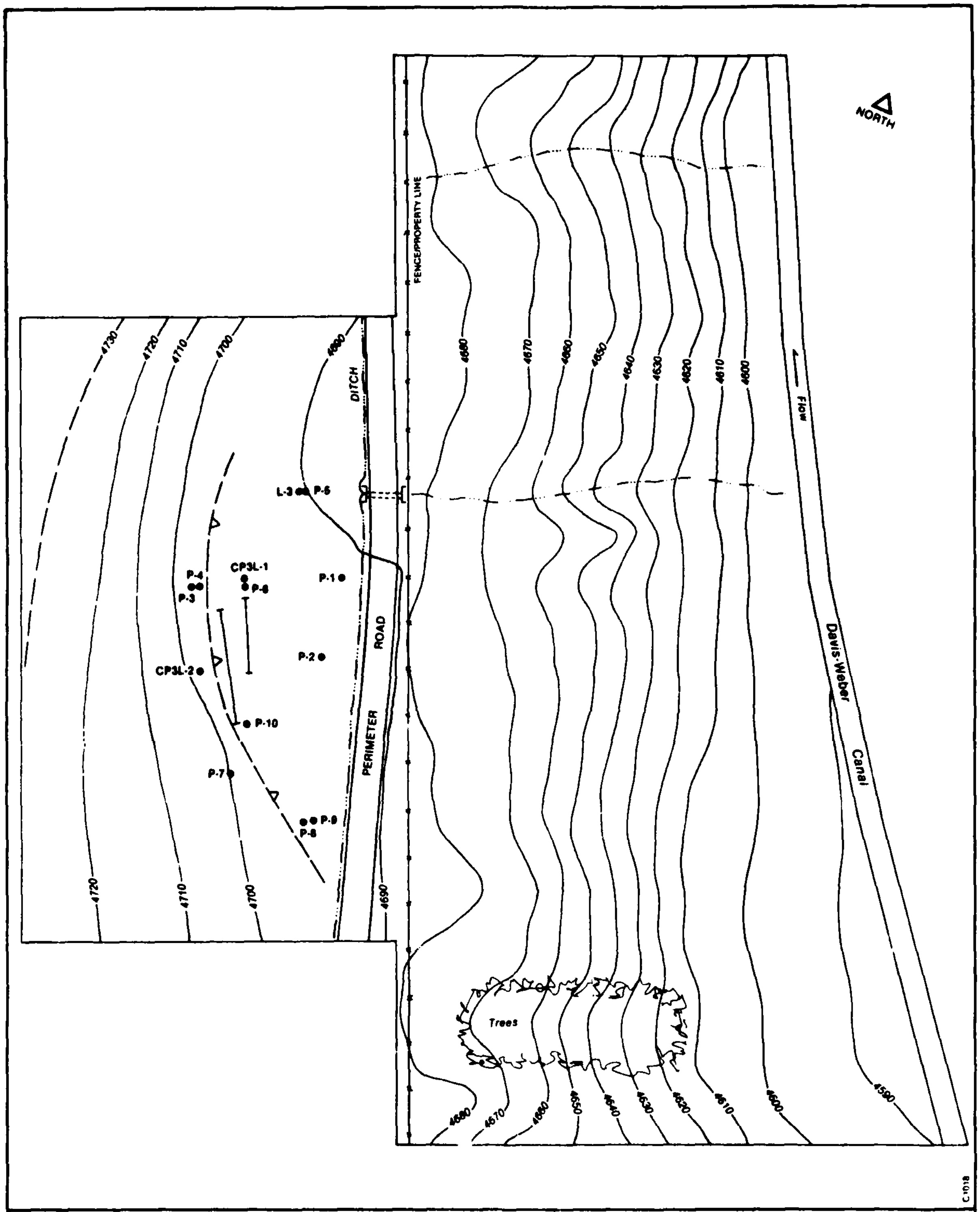

Figure 4-11. Slump Topography East of Chemical Disposal Pit No. 3

Table 4-8

Summary of Soil Sample Analyses for Chemical Disposal Pit No. 3 (Fall 1982)

Analysis	Units	CP3-1	CP3-2	CP3-3	CP3-4	CP3-5A	CP3-5B	CP3-6	CP3-6A	CP3-6B	CP3-7	CP3-8	CP3-9	CP3-10	CP3-11	CP3-12	CP3-13A	CP3-13B	CP3-14	CP3-15A	CP3-15B
TOC	µg/g	18000	14000	3100	13000	6800	4700	4900	2300	2700	6700	6000	12000	3800	7100	6600	1700	5400	8000	3500	3400
TOX	µg/g	<6	<6	<5	<6	<6	<6	<6	<5	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6
Cyanide	µg/g	<11	<12	<11	<12	<11	<11	<11	<11	<12	<12	<11	<12	<11	<11	<11	<10	<11	<11	<12	<12
Beryllium	µg/g	<4	5	<4	49	<5	<5	<5	<4	<5	<5	<4	<5	<4	<4	<5	<4	<5	<5	<5	<5
Cadmium	µg/g	7	290	<4	510	<5	<5	<5	<4	5	<5	<4	220	<4	<4	<5	<4	<5	<5	5	5
Chromium	µg/g	31	170	<22	260	<23	<23	<23	<22	<23	<23	<22	270	<22	<22	<23	<21	<23	<23	<24	<24
Moisture	%	11	14	7.9	15	12	13	13	7.2	14	14	10	18	10	9.3	13	3.7	13	13	15	17

Analysis	Units	CP3A-3	CP3A-4	CP3A-5	CP3A-6	CP3A-7A	CP3A-7B	CP3A-7C	CP3A-8A	CP3A-8B	CP3A-8C	CP3A-9	CP3A-10	CP3A-10A	CP3A-10B	CP3A-10C	CP3A-10D
TOC	µg/g	2900	2800	3100	3200	4100	1400	2300	4700	5400	3100	1300	2300	3500	620	2500	470
TOX	µg/g	<6	<6	<6	<6	<6	<5	<6	<6	<6	<5	<5	<6	<6	<5	<6	<6
Cyanide	µg/g	<12	<13	<12	<12	<12	<10	<12	<12	<13	<11	<10	<12	<11	<10	<12	<12
Beryllium	µg/g	<5	<5	<5	<5	<5	<4	<5	<5	<5	<4	<4	<5	<4	<4	<5	<5
Cadmium	µg/g	<5	<5	<5	<5	<5	<4	<5	<5	<5	<4	<4	<5	<4	<4	<5	<5
Chromium	µg/g	<24	<25	<24	<24	<23	<21	<24	<24	<26	<22	<21	<24	<22	<20	<24	<24
Moisture	%	18	21	16	18	14	4	17	15	22	7	4	16	11	2	15	15

Note: Results have been corrected for % moisture.

for the second round of sampling: barium, iron, manganese, zinc, calcium, magnesium and phenol. A conductivity test was added to the lysimeter sample analyses.

The detailed results of the analyses of the second round of water samples are presented in Appendix Table F-16.

The results of the water sampling are summarized in Table 4-9.

4.1.5.3.2 <u>Reliability</u>. As noted in Section 3.5, the soil analyses were sufficiently reliable to assist in location of the disposal site. The water analyses were generally reliable. The problems with the TOX analysis have been discussed in Section 4.1.1.3.2. It should be noted that the analytical results for volatile components in lysimeter samples (EPA Method 601) may be low because the samples were collected under vacuum. It should also be noted that high levels of some halogenated solvents required that the samples be diluted, thereby elevating detection limits for other components in the EPA 601 analysis for volatile halocarbons.

4.2 Comparison of Chemical Analyses

An integral part of completing a large field program such as the Hill AFB survey is a methodology for systematic interpretation of chemical results. One of the major problems is organizing the hundreds of chemical analysis results to reflect meaningful relationships. Therefore, an approach to compare results, within the sites, was developed to chemically characterize groundwater conditions. This provided a qualitative means to contrast and compare the waste sites and to identify trends. Comparing monitor wells within a waste site provides an examination of the waste site impacts on the local groundwater system(s). Patterns of chemical characteristics or "signatures" can be compared between waste sites for a means to prioritize sites and determine overall impacts to the installation. Analytical groundwater comparisons also provide the basis for designing future groundwater monitoring programs, if needed.

The IRP Phase II Field Investigation has generated a complex data matrix, consisting of a large number of analytical parameters from 30

Table 4-9

Summary of Water Sample and Organic Compounds Detected for Chemical Disposal Pit No. 3 (May 1983)

Analysis	Unit	P-1	P-2	P-3	P-4	P-5	P-6	P-7	P-8	P-9	P-10	CP3L-1	CP3L-2	CP3L-3
TOC	mg/L	58-100	25-44	52-130	2-4	17-160	180-190	13-24	25-43	18-38	34-99	8	5-6	11
TOX	µg/L	150	40	540	600	50	180,000	3,000	40	60	100		3,300	
Phenol	µg/L	<10	<10	20	10	60	15,300	40	<10	10	720	-	-	-
Cyanide	µg/L	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Barium	µg/L	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Beryllium	µg/L	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Cadmium	µg/L	<10	<10	<10	<10	<10	56-100	<10	<10	<10	50	<10	10	<10
Chromium	µg/L	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Iron	µg/L	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Manganese	µg/L	150	90	420	<20	20	2,400	160	350	<20	700	<20	<20	<20
Zinc	µg/L	70	40	50	230	30	540	240	200	50	280	<10	<10	<10
Conduct.	µmho/cm	800-3,300	920	950-1,100	950-1,100	820-910	1,200	1,000-1,800	650-750	640-700	80-1,200	400	1,200	350
Calcium	mg/L	280	40	87	91	13	100	89	60	80	160	87	75	47
Magnesium	mg/L	130	35	51	42	20	60	51	34	29	53	9	94	35

* Denotes a sample which could not be collected.
"-" Denotes an analysis which was not specified for the sample.

Table 4-9 (continued)

Analysis EPA 601	Unit	P-1	P-2	P-3	P-4	P-5	P-6	P-7	P-8	P-9	P-10	CP3L-1	CP3L-2	CP3L-3
Methylene Chloride	µg/L	1-<100	2	7-<100			39,000-63,000	100-<10,000	3-<50	1-<50	16,000-34,000			1,900
1,1,1-Trichloroethane	µg/L	770-2,300	40-56	97	<100-120		150,000-240,000	<10,000-170	56-64	68-89	77,000-81,000	710	170-290	24,000
Trichloroethylene	µg/L	6,200-19,000	160-360	4,000-11,000	1,400-8,800	2-21	280,000-1,100,000	420,000-1,400,000	790-1,700	790-1,700	450,000-610,000	3,700	430-14,000	30,000
1,1-Dichloroethene	µg/L		4				16,000					97		1,800
1,1-Dichloroethane	µg/L		34											
Chloroform	µg/L	130								53				160
1,2-Dichloroethane	µg/L						16,000					11		240
Tetrachloroethene	µg/L										52,000	210		860

monitor wells, piezometers and lysimeters distributed over five study sites. The suite of chemical analyses for the IRP Phase II Field Investigation at Hill AFB were selected based upon the IRP Phase I Records Search. Specific chemical parameters were associated with the wastes at each site. These constituents were determined in the groundwater at each site. A limited group of site-specific constituents were analyzed in the soil samples. The rest of this section will discuss the basis for making analytical comparisons.

Determination of the impacts of waste sites on the local groundwater was based on comparison of the analytical results from an upgradient monitor well to those from downgradient monitor wells in each area studied. No drinking water standards are known to apply to the aquifers investigated. The groundwater under consideration at Hill AFB is not known to be a community drinking water source. Even so, it is felt that the present approach, using upgradient and downgradient monitor well data for water quality comparisons provides a valid means for assessing groundwater impacts related to the waste sites. The remainder of this subsection discusses the results of the analytical comparisons at the various sites.

4.2.1 Chemical Disposal Pits Nos. 1 and 2

The chemical analyses of groundwater collected from the nearby monitor wells indicate that shallow groundwater quality in the vicinity of the pits has been affected by waste disposal at the site. The shallow aquifer has been especially impacted, while the lower aquifer has been impacted, but to a lesser extent. The relative impact on the site was determined by comparing analyses from the downgradient shallow Monitor Wells M-1, M-2, and M-4 with those from the upgradient Monitor Well, M-7 (Figure 4-3). Since a lower aquifer also exists, results from deep Monitor Well M-3 (downgradient) were compared to those from Monitor Well M-6 (upgradient). The priority of comparisons was between monitor wells constructed using similar completion techniques. Monitor Wells W-7 and W-8 were constructed during an earlier investigation of Landfill No. 4 using different completion techniques.

As previously discussed, Table 4-3 depicts the inorganic and organic compounds analyzed in the groundwater samples obtained. Most parameters were detected in the shallow downgradient wells and to a lesser degree in samples from the lower aquifer.

Table 4-10 presents a relative contamination ranking by monitor well. This ranking reflects the numbers and amounts of contaminant species detected in groundwater with respect to upgradient concentrations. For the shallow aquifer, Monitor Well M-2 had the greatest amount of contaminants detected followed by Monitor Wells M-1 and M-4. Of the inorganic species detected in the shallow aquifer, values above background were for iron, manganese, and zinc. For the indicater parameter of TOC downgradient values of approximately 14 mg/L contrasted significantly with the background value of about 3 mg/L. Phenols were detected at concentrations up to about 25 times that of observed in the background well. Chlorinated solvents were found in downgradient samples (see analyses on Table 4-3).

For monitor wells completed in the lower aquifer few differences in inorganic concentration were noted between the upgradient versus downgradient wells. Organic parameters of carbon tetrachloride, trans,1,2-dichloroethene, chlorobenzene, benzene and toluene were detected in water at the deep downgradient Monitor Well M-3. No chlorinated solvent compounds were detected in the upgradient Monitor Well M-6. Some base neutral extractable compounds were detected, but due to the nature of the analytical process and the near detection limit levels of reported values the data may not accurately reflect contamination.

4.2.2 Landfill No. 3

The chemical analyses of groundwater collected from the nearby monitor wells indicate that shallow groundwater quality in the vicinity of the landfill has been affected by waste disposal at the site. Table 4-4 lists the inorganic and common organic compounds analyzed and detected in the groundwater samples obtained. The basis for evaluating the relative impact of the landfill was by comparison of data from the downgradient shallow Monitor Well M-9 with data from the primary upgradient Monitor

Table 4-10.

Monitor Well Relative Contamination
Ranking at Chemical Disposal Pits Nos. 1 and 2 and Landfill No. 3

Chemical Disposal Pits Nos. 1 and 2

Shallow Monitor Wells	(Inorganics)	M-2 > M-1 > M-4 > M-7[1]
	(Organics)	M-2 > M-4/M-1 > M-7[2]
Lower Aquifer Monitor	(Inorganics)	M-3 approximately M-6
	(Organics)	M-3 > M-6

Landfill No. 3

Shallow Monitor Wells	(Inorganics)	M-9 > M-7 > W-7/W-8
	(Organics)	M-9 > W-7/W-8/M-7
Lower Aquifer Monitor	(Inorganics)	M-10 > M-6
	(Organics)	M-10 > M-6

[1] Underlining deontes primary upgradient monitor well.
[2] Only one organic compound found at detection limit of 1 µg/L.

Well M-7. Monitor Wells W-7 and W-8 (Figure 4-3) are also upgradient but on the west side of the landfill. Inorganic analyses for Monitor Wells W-7 and W-8 were comparable to that of Monitor Well M-7.

Seven (7) inorganic parameters; sulfate, manganese, calcium, magnesium, sodium, potassium, and bicarbonate averaged about a 5-fold increase in concentration in groundwater samples from the downgradient shallow Monitor Well M-9 relative to samples from the upgradient Monitor Well W-7. The largest increases in concentration were for iron and chlorides which were detected at levels of about 29 and 15 times background. These increases in inorganic constituents most likely reflect the impact of Landfill No. 3 as the location of Monitor Well M-9 for the shallow aquifer is very near the toe of Landfill No. 3.

To evaluate impacts to the lower aquifer, downgradient conditions at Monitor Well M-10 were compared with upgradient conditions at Monitor Well M-6. Some contamination was detected in the lower aquifer. It is not certain that the landfill leachate is the sole contributor of the inorganic species. One exception may be chlorides, which had about a four-fold increase downgradient (approximately 50 mg/L in Well M-6 versus approximately 175 mg/L in well M-10). Other increases may be due to natural changes in groundwater composition resulting from flow through a clay matrix.

On the other hand, very few organic compounds were detected. All compounds detected were in samples from the downgradient Monitor Well M-10. The parameters noted were trichloroethylene, chlorobenzene, 1,2-dichlorobenzene, and ethyl benzene. All parameters were near the detection limits except for 1,2-dichlorobenzene which had a value of 200 μg/L versus a detection limit of 5 μg/L. Results are presented in Table 4-4.

Table 4-10 depicts a relative ranking of the monitor wells associated with Landfill No. 3 in terms of the degree of contamination observed. The ranking is based upon noting the greatest changes in analyte concentration between the upgradient and downgradient monitor wells. In general, shallow Monitor Well M-9 showed the greatest degree of contamination. On

the other hand, Monitor Well M-10 in the lower aquifer had some organic contamination, but at levels generally lower than for Monitor Well M-9.

4.2.3 Golf Course

The golf course area was investigated to determine if a hydraulic connection exists between it and the topographically lower areas in the vicinity of Landfill No. 3 and Chemical Disposal Pits Nos. 1 and 2. To accomplish this, one well (GC-1) was emplaced on the golf course and the groundwater was sampled. Additionally groundwater samples were obtained from two pre-IRP Monitor Wells 80-19 and W-13 which are close to the golf course for analytical comparisons to Well GC-1 (Figure 4-3). The analytical results are presented in Table 4-5.

Hydrogeologic evidence gathered to date are not conclusive regarding the possible hydraulic connection between the golf course area and the waste sites. Therefore the golf course well represents a single control point. Nothing unusual was noted in the inorganic analyses of samples from Well GC-1. Parameter values are similar to those from Monitor Wells 80-19 and W-13. No organic solvent compounds were detected in Well GC-1. Several other organic compounds (i.e. Base/Neutral Extractables) were noted but due to the nature of the analytical process and the near detection limit levels of reported values the data may not reflect actual field conditions signifying contamination. If the golf course area is determined to be hydraulically connected to the waste site areas in follow on activities, it would be suitable for a background well.

4.2.4 Berman Pond

Two monitor wells were emplaced in the area of Berman Pond (Figure 2-24). One monitor well was used to represent upgradient conditions while the other was used to define downgradient conditions. The results of the field investigation indicate that the monitor wells are completed in two different aquifers. Monitor Well BPM-1 appears to be completed in a low productivity water table aquifer. In contrast the aquifer at Monitor Well BPM-2 is screened across an artesian system, most likely an old Weber Delta stream bed, which is very productive. Because the two monitor wells are in two different aquifers, resulting data cannot be used comparatively

to determine potential impacts of Berman Pond on the local groundwater systems.

Four (4) lysimeters were emplaced around Berman Pond at depths to 16 feet below ground level. The monitor wells were completed about 85 and 109 feet below ground level. To the extent possible the results of the chemical analyses from the monitor wells were compared to those from the lysimeters. The lysimeters may be able to represent leachate compositions that may be coming from Berman Pond. This could provide indications of vertical migration to underlying aquifers.

Comparisons of the inorganic compounds analyzed from Table 4-7 indicate that lysimeter values for calcium are on the order of 4 times those of ground water from the two monitor wells. This in and of itself does not indicate contamination migration or specifically attribute the source of contamination to Berman Pond. No other inorganic compounds detected were comparable.

On the other hand some organic compounds were detected in the lysimeters and monitor well analyses. However, direct correlations were difficult due to the limited number of results which were close to the detection limits. The main compounds detected were chlorinated solvents and several aromatic hydrocarbons. Generally the detected values from the monitor well samples were very low and close to the analytical detection limits. Lysimeter BPL-1 (Figure 2-24) had distinctly higher amounts of chlorinated solvents with respect to the other lysimeters and the monitor wells. The compounds detected at elevated levels were 1,1,1-trichloroethane (160 micrograms/L) and tetrachloroethene (200 micrograms/L). It is difficult to attribute the organic solvents to Berman Pond due to the distance of the lysimeters from the pond and the number of subsurface water lines.

In general it is not certain that Berman Pond is impacting local subsurface conditions. The analytical results vary laterally and vertically. Additional investigations will be required to define the waste site's impact on the local hydrogeology, if any.

4.2.5 Chemical Disposal Pit No. 3

Based on the results of this investigation the groundwater at all ten piezometers and three lysimeters at Chemical Disposal Pit No. 3 contains chlorinated solvents. The amount of solvents detected in the groundwater ranged from about 1 microgram/L to 1,400,000 microgram/L. The largest amounts were detected in Piezometers P-6, P-7, and P-10 of 1,100,000, 1,400,000, and 610,000 micrograms/L respectively. The chlorinated solvents detected in large concentrations were methylene chloride, 1,1,1-trichloroethane, trichloroethylene, tetrachloroethane, 1,1- and 1,2-dichloroethene. Other compounds detected at lower concentrations were 1,1-dichloroethene, 1,1-dichloroethane, and chloroform. Phenols were also detected in many of the piezometers with the highest value being 15,300 micrograms/L at Piezometer P-6.

The presence of organic solvents in the shallow lysimeters provides an indication that chemicals are actively leaching through the soil. Since the empty pits are exposed at the ground surface, precipitation is the main means of leachate generation.

For the metals analyses of groundwater, cadmium, manganese, and zinc were detected. Piezometer P-6 has the highest amounds of contaminants. Beryllium, cadmium, and chromium were detected in four soil samples taken directly from the bottom of the pits at locations CP3-1, CP3-2, CP3-4, and CP3-9 on Figure 2-25. This correlates with the field observations of waste materials (Figure 4-9). The presence of the metals is expected because of reports that the bottoms from plating operations may have been disposed of in the pits. The presence of some of the metals in the soil may suggest a source of the metals detected in the groundwater at Piezometer P-6, P-10 and of the cadmium found in Lysimeter CPL-2.

Upgradient versus downgradient directions were initially unknown due to the complexity of geology at Chemical Disposal Pot No. 3. For this study Piezometers P-3, P-4 and P-7 located on the west side of the slump fault (Figure 4-10) represent upgradient conditions. All three piezometer samples had organic solvents in them. Piezometer P-7 had the highest amounts, not only compared to Piezometers P-3 and P-4, but relative to all

of the other downgradient piezometers at the site. The full extent of the contamination at the site is unknown. Based upon existing data, the source of the upgradient chemicals is probably not entirely from the present pits but may reflect some other upgradient source. The upgradient source is probably south to southwest of the disposal pits. Additional field investigations will be needed to define the source, nature, and extent of the contamination.

4.2.3 Reliability of Chemical Analyses

The analytical methods used for determination of the organic species were EPA-approved. In the first sampling episode, gas chromatography-mass spectrometry (GC/MS) was used in addition to other techniques.

The GC/MS methods, in general, are considered to be quite reliable, particularly in regard to identification of the analytes. Quantification by GC/MS is only fair (semi-quantitative) and less precise than by other gas chromatographic methods using specific detectors (i.e., the photoionization detector (PID) or the Hall detector).

Because of the relatively low precision and high expense of GC/MS analyses, less costly but more precise GC-PID or GC-Hall methods were used exclusively in the second sampling episode. These methods are more subject to interference than GC/MS. However, it was felt that since the presence of the various organic parameters had been established in the first sampling by GC/MS, the use of the less costly methods was justified in later samplings.

In certain cases the presence of very high concentrations of a particular analyte, such as TCE at Chemical Disposal Pit No. 3, may preclude the accurate analysis of other compounds due to interference or the need to dilute the sample below the detection limits of the other compounds. In these cases, only one or two organic species may be reported in the very high concentrations. This should not be viewed as a serious method fault, however, since the presence of even one analyte at high levels is enough to warrant continued investigation of a particular sample site.

The method used for total phenols is a relatively simple colorimetric procedure and is susceptible to interferences. High results by this method, therefore, should be viewed with caution and checked by other procedures.

An important consideration when comparing chemical analyses is the analytical detection limit. The analytical detection limit may vary from one time period to another due to instrumental condition or changes in a sampling matrix and/or sample volumes. Significant changes in the detection limit can indicate a problem in the analytical method or the instrumentation. These problems were resolved before the samples were analyzed and then the detection limit was calculated at the time of analysis. As an analysis approaches the analytical detection limit, an increase in uncertainty is associated with the analytical value.

4.3 Significance of Findings

Based upon the IRP Phase II Field Investigation results the following information can be derived.

4.3.1 Extent of Contamination

The extent of contamination can be defined only as accurately as the data base permits. Two sites (Berman Pond and Chemical Disposal Pit No. 3) were unstudied prior to this investigation. Limited data obtained during previous investigations of Landfill No. 4 were available for Chemical Disposal Pits No. 1 & 2. Additional data were generated by this study. Landfill No. 3 had the largest amount of hydrogeologic information available. It had been developed during past investigations of Landfill No. 4. In spite of the variation in the quality and quantity of data available, certain trends in the relative impacts of the waste sites can be briefly discussed. Data are insufficient to be able to make a complete estimate of the areas and volumes of groundwater impacted.

The two smallest disposal areas (Chemical Disposal Pits No. 1 & 2 and Chemical Disposal Pit No. 3) have affected the largest groundwater areas by past disposal activities at the Base. Though their areas are much smaller than Landfill No. 3, the relative impacts of the two sites appear

quite large. Based on the present data the areas impacted are greater than 13 acres. The main reason for the areal impacts is that large quantities of fluids were disposed at these small pits while solids were the principal wastes at Landfill No. 3. Berman Pond also received large volumes of waste fluids but its impact on groundwater could not be readily assessed.

In the case of Chemical Disposal Pit No. 3, the assessment of groundwater impacted could not be reliably computed due to the numerous pathways for potential contaminant migration through the slump feature and the absence of downgradient hydrogeologic data. The thicknesses of the flow paths in the aquifers at the pit range from fractions of a millimeter along the slump fault planes to greater than 23 feet in the sand zones, with significant changes over short distances. The approximate lateral extent of downgradient groundwater impact could encompass 14 acres between the Base boundary and the Davis Weber Canal. Migration east of the canal is a possibility because it is also located on the slump complex.

Contaminated soil outside Chemical Disposal Pits No. 1 & 2 was due to waste fluids migrating along the top of the groundwater surface, as evidenced by oil slicks at two nearby previously installed monitor wells (W-4 and 80-20) to the west. The lateral extent and thickness of the oil is unknown. The migration of the waste products from the pits is primarily in the direction of the groundwater flow component to the northwest with a probably secondary component to the north. The main groundwater flow goes to the northwest, out of the area of data control.

4.3.2 Evaluation of Contamination

In order to provide an evaluation of the contamination it is necessary to conduct some form of risk assessment. Generally, a full scale assessment is an intensive study involving a variety of environmental disciplines. The results can provide quantitative and qualitative evaluations of risk to target receptors. Risk evaluations address several factors: transport route and concentration of contaminant; population-at-risk; and toxicity data. Any or all of these factors may be addressed at any one time.

Downgradient and off-Base groundwater receptors, uses and contaminant concentration are presently unknown. The data are insufficient to conduct a risk assessment at this time. Additional data from follow-on studies, and OEHL risk assessment guidelines which are being developed will be needed to fully evaluate the contamination.

5.0 ALTERNATIVE MEASURES

Three of the four waste disposal sites studied at Hill AFB require additional investigations in order to develop a sufficiently detailed data base for remedial action design. This section summarizes the conditions for each waste site. Site specific recommendations for these additional investigations are enumerated in Section 6.0.

Four inactive waste disposal sites were investigated to determine locations and impact on local groundwater systems. The Golf Course was investigated to determine the presence of groundwater. The sites were investigated utilizng a coordinated multidisciplinary team representing hydrogeology, geophysics, and chemistry. Additionally, preliminary information on Landfill No. 4 developed during this study warrants a brief comment. General site status is provided for each area as follows:

1. Chemical Disposal Pits Nos. 1 & 2: The sites were located and a plume was identified. The plume was also found to extend beyond the area of current monitor well control. Local hydrogeologic conditions were defined to include an underlying shallow clay layer. Downgradient and off-site conditions beyond the present data base are unknown. Field investigations will be required to define the plume and downgradient hydrogeologic conditions. Any remedial action design would have to consider the present sites and plume identified.
2. Landfill No. 3: A contamination plume was detected but not completely defined downgradient of the landfill. The local hydrogeology has been defined to include the underlying clay and the identification of an aquifer under the clay.
3. Golf Course: Groundwater was found below the Golf Course which can contribute groundwater underflow to the topographically lower disposal areas. Available information suggests that any remedial action at the topographically lower disposal areas should address the effects of groundwater underflow.

4. <u>Landfill No. 4:</u> Some monitor wells installed prior to this investigation are believed to be screened across the shallow and the lower aquifers; in addition, some of these wells with either partial construction and/or entire casing are perforated. Therefore, it is recommended that the well construction data and screened horizons be evaluated to assess the usefulness of these wells as monitor wells under the remedial actions program. This assessment would also include the identification and locations of other monitor wells.

5. <u>Berman Pond</u>: Based upon present data, the approximate areal extent of the pond has been identified, local hydrogeology has been determined, and the absence of shallow perched groundwater has been confirmed. Two deep aquifers at depths greater than 90 feet were found. If leachate is being generated at the pond, it would not be the result of groundwater intrusions but would be predominately from infiltration of precipitation and possible leakage from utility water lines. Chemical analyses from the shallow lysimeters and deep monitor wells indicate contamination in the groundwater; but due to the complexity of hydrogeologic conditions, the impact of Berman Pond on the groundwater is uncertain and cannot be reliably stated. Additional field investigation would be needed to define any impact on the local groundwater systems and to assess the potential for continued generation of leachate from the pond area.

6. <u>Chemical Disposal Pit No. 3</u>: The disposal pit was located and found to be sited in a complex landslide slump block. The local hydrogeology was determined and solvents were detected in a perched shallow groundwater system. Additional solvents were detected upgradient of the pit(s). The source of these solvents is unknown. Downgradient and off-site conditions are unknown. Additional field investigation is recommended to identify other sources (s) of solvents and to assess the extent of impacts.

Amplified discussions of waste site conditions are presented below.

5.1 Chemical Disposal Pits No. 1 & 2

5.1.1 Summary of Existing Conditions

Prior to this study, data were available primarily for the areas to the east of Chemical Disposal Pits No. 1 & 2. The pits had not been studied in detail. Most of the available information had been developed during studies of Landfill No. 4 to the east. The information developed during this study helped to locate the pits, define the hydrogeologic system at the pits, and assess their probable impact upon the groundwater system. An oil slick and contamination plume have been detected trending northwest from the pits along a primary groundwater flow path. The hydrogeologic data suggest that there may also be a portion of the plume migrating north/northeast from the pits. The only monitor well north of the pits (M-4) is located where the underlying clay forms a high point around which groundwater would tend to preferentially flow (i.e., northwest and north/northeast). Based upon a limited number of oil thickness and water level measurements at the disposal pits it was found that the oil slick does not appear to be migrating. The oil apparently became trapped in drier formations as a result of rising water levels associated with the unusually large amount of winter and spring precipitation.

5.1.2 Additional Data Requirements

In order tc adequately define the contaminant plume at Chemical Disposal Pits No. 1 & 2, additional monitor wells and/or piezometers are needed to (1) identify the dimensions of the plume to the northwest beyond the present area investigated, (2) detect the limits of the known oil slick, (3) monitor the oil slick and groundwater levels around the pits to determine the thickness and movement of the oil slick, and (4) detect any contamination or oil slick occurring north/northeast of the pits. Specific recommendations are provided in Section 6.0.

5.2 Landfill No. 3

5.2.1 Summary of Existing Conditions

This site is adjacent to the previously studied Landfill No. 4. Therefore, a significant amount of hydrogeologic data were available at the start of the study. This IRP Phase II study defined conditions upgradient and downgradient of the landfill area. As a result of the unusually high precipitation and resultant high groundwater levels this year, groundwater has intruded into the base of the landfill. The degree of groundwater intrusion can be expected to be minor or nonexistent in normal or dry years. Therefore, most leachate development from the landfill can be attributed to fluids contained in the waste materials in the fill or vertical infiltration of precipitation through the landfill cover.

Groundwater tends to flow northward from Landfill No. 3. Some of this groundwater may mix with flow from Landfill No. 4 and contribute to the seeps to the northeast which are the subject of an ongoing Hill AFB monitoring program. Additionally, leachate from the west side of the landfill may combine with leachate from Chemical Disposal Pits No. 1 & 2. No data are yet available to verify this. Previously installed monitor wells W-9, 80-21, and W-14 north of the landfill may be unreliable due to surface runoff collecting at the wells and flowing down the casing through the above-ground perforations in several of them.

5.2.2 Additional Data Requirements

The quality of groundwater to the north needs to be further examined. Furthermore, groundwater levels during the dry season need to be observed in order to assess the potential for groundwater intrusion into the waste material. Additional wells are needed west of monitor wells M-9 and M-10 to clarify the impact of Landfill No. 3 on groundwater chemistry. These specific activities are noted in Section 6.0.

5.3 Hill AFB Golf Course

5.3.1 Summary of Existing Conditions

Previous reports suggested the possibility of near surface groundwater occurrence at the Golf Course, but no data were available. This IRP Phase II investigation demonstrated the existence of shallow groundwater at the Golf Course. Irrigation of the Golf Course appears to promote direct groundwater recharge to Chemical Disposal Pits Nos. 1 & 2, Landfill No. 3, and Landfill No. 4 which are topographically lower. Data collected on the groundwater levels and the chemistry of groundwater suggest that the groundwater at the Golf Course is hydraulically connected with the aquifer system underlying the Chemical Disposal Pits Nos. 1 & 2 and Landfill No. 3 and possibly at Berman Pond. Groundwater level measurements were taken prior to the irrigation season of the Golf Course and, therefore, do not reflect hydrologic conditions during the irrigation season.

5.3.2 Additional Data Requirements

In order to verify that Golf Course irrigation results in recharge to the aquifer system, it is recommended that static water levels be measured in selected monitor wells during the peak irrigation season. This will aid in verifying recharge from the Golf Course and assessing the relative magnitude of impact. Depending upon the results of the water level measurements, additional activities may be required to define the Golf Course recharge and potential impact on the lower disposal areas. Specific recommendations are described in Section 6.0.

5.4 Landfill No. 4

5.4.1 Summary of Existing Conditions

During the course of the present Phase II IRP investigation at Hill AFB, it was learned that a clay cap is being considered for Landfill No. 4. Before placement of a cap, it is recommended that the disposition of the 39 monitor wells previously constructed in the landfill areas and the impact of the clay cap on the present groundwater system be evaluated. During the data review, it was noted that some of the monitor

wells may be screened in both the shallow and lower aquifers. The existence of a lower aquifer was confirmed during this study. Both aquifers are expected to have similar hydraulic heads in the vicinity of Landfill No. 4.

5.4.2 Additional Data Requirements

Possible implications of clay cap emplacement include: (1) leachate may be able to migrate downward through the old monitor wells to the lower aquifer, if the monitor wells are covered without being properly sealed or abandoned; (2) the chemical analysis may not be representative of one distinct aquifer if any of the monitor wells to be retained are screened across two aquifers; (3) the reduction in direct infiltration may result in a decrease in hydraulic head in the upper aquifer which may induce upward flow from the lower aquifer. Emplacement of a clay cap at Landfill No. 4 should be reevaluated, utilizing the information developed in this report, to insure that the clay cap will provide the desired results. As a minimum, the final disposition (abandonment/continued use) of the existing monitor wells in the area should be examined. Specific items of consideration are addressed in Section 6.0.

5.5 Berman Pond

5.5.1 Summary of Existing Conditions

The results of this investigation provided some details on the subsurface stratigraphy but do not conclusively indicate whether the contaminated soils at Berman Pond are actively leaching into the subsurface.

The clay beds encountered below the pond area appear to be nonuniform and possibly discontinuous. The tops of these clays are not sufficiently defined to determine the presence of leachate and/or preferred leachate paths; particularly for any off-base migration. No shallow perched groundwater was noted during this investigation which indicates that groundwater is not flowing through the contaminated pond soils and generating leachate. Therefore, if any leachate generation is occurring, it would be primarily from precipitation and/or leaks from sewer or water

lines. The leakage from the pond that may have occurred during the operation of the pond has likely migrated away from the site. However, the direction and rate of migration of the past leakage and the rate of generation of any present leachate is unknown. Available data suggest that underlying natural materials would tend to provide some leachate attenuation, although the identification of the retained (adsorbed) species and the amount of retention are unknown.

Contaminants were detected in monitor wells BPM-1 and 2, but due to the low values and nature of the analytical process it may not represent cause for concern. The source of potential contaminants is unknown. The contaminants may be from a source(s) upgradient or from Berman Pond; if they represent leachate from Berman Pond, apparently the underlying clays do not prevent downward migration of these contaminants. On the other hand, contamination was observed from the shallow lysimeters BPL-1 and 2 at Berman Pond. Although this contamination may be attributed to disposal activities at Berman Pond, these chemical constituents could also result from other sources including run-on, utility lines crossing the pond area, a temporary drainage ditch previously located in the area, or soil disruption during recent storm drain line replacement.

5.5.2 Additional Data Requirements

To reduce the uncertainties of whether or not the pond continues to generate leachate and to assess the effectiveness of a cap system, additional field investigations should be considered. These could be to determine (1) if Berman Pond is actively generating leachate and, if so, (2) define the extent and orientation of the deep underlying clays along which leachate would tend to migrate.

5.6 Chemical Disposal Pit No. 3

5.6.1 Summary of Existing Conditions

Prior to the IRP Phase II Field Investigation, no hydrogeologic data were available for Chemical Disposal Pit No. 3. The information developed during this study has resulted in the identification of contaminants in groundwater and in the determination that hydrologic conditions at the

site are extremely complex. However, further data are required in order to adequately evaluate and design remedial measures.

The site is located on a geologically complex slump feature in which distinct variations in geology and hydrology occur within tens of feet both areally and vertically. The primary contaminants found were solvents (principally trichloroethylene). The site was found to have greater amounts of solvents in the groundwater than the other sites studied. The groundwater flows in a generally northeast direction toward the base of the slump and off Hill AFB property. The extent of the slump has been only partially defined on the basis of geophysical surveys and topography. Partial structural detail is available near the head of the slump where Chemical Disposal Pit No. 3 is located.

The occurrence of solvents upgradient of the site suggests that there may be another source of solvents in the area. A possible source may be an additional, unrecorded pit. There are insufficient data to define the solvent source. Additionally, direction and quality of groundwater flow off-base are unknown.

5.6.2 Additional Data Requirements

Chemical Disposal Pit No. 3 requires further investigation to (1) define additional source(s) of solvents in groundwater, (2) to assess off-base groundwater, and (3) to determine whether this groundwater is a potential threat to off-base property or personnel. Specific recommendations are contained in Section 6.0.

6.0 RECOMMENDATIONS

The supporting general comments and considerations concerning the disposal sites were addressed in Section 5.0. This section provides the specific recommendations pertaining to each site based upon the results of this Phase II IRP field investigation. The recommendations for each site are found on tables as follows:

- Chemical Disposal Pits Nos. 1 & 2 - Table 6-1
- Landfill No. 3 - Table 6-2
- Landfill No. 4 - Table 6-3
- Golf Course - Table 6-4
- Berman Pond - Table 6-5
- Chemical Disposal Pit No. 3 - Table 6-6
- General Recommendations - Table 6-7

The recommendations in the tables have been placed in order of priority of execution as much as practical in order to facilitate allocation of resources for future programs by the Air Force.

TABLE 6-1. CHEMICAL DISPOSAL PITS NOS. 1 & 2 RECOMMENDATIONS

Recommendation	Rationale
1. Conduct chemical analyses on ground-water samples from Monitor Wells M-1, 2, 3, and 4 as follows: 1a. Initially for Primary and Secondary drinking water standards; annually thereafter, or before initiation of remedial actions. 1b. Initially for selected organic and inorganic pollutants; annually thereafter, or before initiation of remedial actions. 1c. Initially for major anions and cations; annually thereafter, or before initiation of remedial actions.	To establish baseline ground-water quality and classification for future comparisons.
2. Conduct quarterly ground-water sampling for selected indicator parameters at Monitor Wells M-2 and M-3 (deep) along with RCRA parameters of ground-water quality and indicators of contamination.	To conduct a ground-water monitoring program on selected monitor wells establishing seasonal and pre-remedial action ground-water quality.
3. Examine downslope areas to identify the occurrence of slump features.	Previous reports (Pashley, 1971) indicated that a portion of the South Weber Landslide complex may be situated northwest of Chemical Disposal Pits Nos. 1 & 2. This feature may be structurally controlling ground-water flows from the disposal sites.
4. Identify and inventory all springs and seeps on the downslope area.	The springs and seeps represent the intersection of the ground-water table with the land surface where contaminated ground water may be surfacing. Air Force studies have previously identified springs and seeps associated with Landfill No. 4 contamination problems.
5. Collect water samples from all springs and seeps for chemical analyses of selected indicator parameters along with RCRA indicators of ground-water quality and contamination.	To establish if contaminated ground water is surfacing downslope from the disposal pits.
6. Emplace up to six 2-inch monitor wells about previous Monitor Wells W-4 and 80-20 to define the "oil slick".	An oil slick has been noted as early as 1976 which apparently has not physically migrated away from the pits but maybe trapped in the formations. No studies have been conducted to define the oil slick to provide data for remedial actions.
7. Emplace up to three 2-inch monitor wells north-northeast of the disposal pits.	IRP Phase II data indicated that contaminated ground water is moving out of the present area of monitor well control. These wells will provide data on ground-water and clay distribution.

TABLE 6-1. CHEMICAL DISPOSAL PITS NOS. 1 & 2 RECOMMENDATIONS (Continued)

Recommendation	Rationale
8. Emplace up to four 2-inch monitor wells west and northwest of Monitor Wells M-2 and M-3 into the shallow aquifer and two 2-inch monitor wells in the lower aquifer using the hollow stem auger method.	IRP Phase II data indicate that contaminated ground water is moving out of the present area of monitor well control. The ground-water flow direction is unknown. These will help to define ground-water flow directions and water quality. Should hydrogeologic conditions exceed the capabilities of the hollow stem auger rig, then utilize an air rotary rig to emplace up to three 6-inch monitor wells.
9. If the existence of a portion of the South Weber Landslide complex is verified (see Item 7), emplace up to five 2-inch monitor wells in that area.	To define the downslope ground-water gradients, and contaminant flow directions.
10. Sample ground water from new monitor wells and incorporate them into the monitoring program.	To incorporate new monitor wells into the IRP Phase II monitoring program for parameters noted in Items 3 and 4.
11. Survey elevations and/or location of monitor wells, springs, seeps, and ground level control points.	To provide accurate elevation and control data for determining ground-water flow directions.
12. Conduct a downslope water well inventory within 1/2 mile of the base boundary.	To provide data and verify any shallow ground-water users that may be impacted by off-base migration of leachate.
13. Conduct waste pit coring of 3-core holes (1 in the pits and 2 outside of the pits).	To provide chemical and field data on the nature and extent of the wastes at the pits to support remedial action design.

TABLE 6-2. LANDFILL NO. 3 RECOMMENDATIONS

Recommendation	Rationale
1. Conduct chemical analyses on ground-water samples from Monitor Wells M-6, 7, 9, and 10 as follows: 1a. Initially for Primary and Secondary drinking water standards; annually thereafter, or before initiation of remedial actions. 1b. Initially for selected organic and inorganic pollutants; annually thereafter, or before initiation of remedial actions. 1c. Initially for major anions and cations; annually thereafter, or before initiation of remedial actions.	To establish baseline ground-water quality and classification for future comparisons before remedial actions.
2. Conduct quarterly ground-water sampling for selected indicator parameters at Monitor Wells M-9 and 10 (deep) along with RCRA parameters of ground-water quality and indicators of contamination.	To conduct a ground-water monitoring program on selected monitor wells establishing seasonal and pre-remedial action ground-water quality.
3. Conduct a round of measurements of groundwater levels, in situ temperatures, and conductivity during the "dry" summer season at Monitor Wells M-6, 7, 9, and 10.	To establish seasonal ground-water variations by providing data for contrasting summer and winter measurement, specifically to define groundwater flow pattern(s) during the "dry" season as well as to qualitatively determine waste site impacts on the groundwater. (Note: a limited program has been authorized by the Air Force and is ongoing.)
4. Identify and inventory all springs and seeps on the downslope area.	The springs and seeps represent the intersection of the ground-water table with the land surface where contaminated ground water may be surfacing. Air Force studies have previously identified springs and seeps mainly associated with Landfill No. 4. New ground-water discharges may result from the unusually high precipitation this year.
5. Collect water samples from all springs and seeps for chemical analyses of selected indicator parameters along with RCRA indicators of ground-water quality and contamination.	To establish if contaminated ground water is surfacing downslope.
6. Emplace two shallow and one deep 2-inch monitor wells north of the Landfill No. 3.	IRP Phase II data indicated the contaminated ground water is most likely moving north out of the present area of monitor well control. This will provide data on ground-water flow and top of clay distribution, as well as hydrogeologic control where previous monitor wells (W-9, 80-21, and W-14) hydrologic data may not be reliable. Should hydrogeologic conditions exceed the capabilities of the hollow stem auger rig, then utilize an air rotary rig to emplace a deep monitor well.

TABLE 6-2. LANDFILL NO. 3 RECOMMENDATIONS (continued)

Recommendation	Rationale
7. Emplace up to three 2-inch monitor wells downslope of Perimeter Road.	To define the downslope ground-water gradients, and contaminant flow directions.
8. Sample ground water from new monitor wells and incorporate them into the monitoring program.	To incorporate new monitor wells into the IRP Phase II monitoring program for parameters noted in Items 3 and 4.
9. Survey elevations and/or locations of monitor wells, springs, seeps, and ground level control points.	To provide accurate elevation and control data for determining ground-water flow directions.
10. Conduct a downslope water well inventory within 1/2 mile of the base boundary.	To provide data and verify any shallow ground-water users that may be impacted by off-base ground-water flows.
11. Add the fire protection training areas (old and new) to this area investigation. Emplace two (2) monitor wells between each of the old and new training areas and Landfill No. 3/Chemical Disposal Pits Nos. 1 and 2 area. Take soil cores from the old fire training pit for chemical analyses.	These fire training areas were not a direct part of this investigation. It is possible that these facilities as well as leachate from Landfill No. 3 are contributing contaminants to the shallow groundwater. Analyses of the soil cores at the old fire training pit will characterize any contaminants that may have infiltrated through the pit.
12. Emplace one 2-inch monitor well at the fire training area located by Landfill No. 3 to obtain ground-water for chemical analysis.	The fire training area was indirectly investigated during this study. Its impact on the local ground-water system, if any, is unknown.

TABLE 6-3. LANDFILL NO. 4 RECOMMENDATIONS

Recommendation	Rationale
1. Conduct a detailed review of construction and hydrogeologic data for the 39 monitor wells installed prior to this investigation.	To determine the suitability of these wells for use in a monitoring program.
2. Review the plans for capping of Landfill No. 4 in light of the results of this investigation.	To determine projected monitoring requirements, and to evaluate whether hydrogeologic findings in this study affect the design or effectiveness of the cap.
3. Develop final recommendations regarding disposition of existing monitor wells at Landfill No. 4.	To ensure that wells to be abandoned are properly sealed and that those wells intended for continued use are suitable for such use. These recommendations will take into account the information developed in Items 1 and 2 above.
4. Survey the location of Monitor Well 80-9.	The data and maps available depict Monitor Well 80-9 outside of the previously determined Landfill No. 4 area. This may be on early trench area of the landfill or other disposal cells not previously known. Surveying the location would provide a means to cross-check the location of the western side of Landfill No. 4.

TABLE 6-4. GOLF COURSE RECOMMENDATIONS

Recommendation	Rationale
1. Conduct chemical analyses on ground-water samples from Well GC-1 as follows: 1a. Initially for Primary and Secondary drinking water standards; annually thereafter, or before initiation of remedial actions. 1b. Initially for selected organic and inorganic pollutants; annually thereafter, or before initiation of remedial actions. 1c. Initially for major anions and cations; annually thereafter, or before initiation of remedial actions.	To establish baseline ground-water quality and classification for future comparisons before remedial actions at Chemical Disposal Pits Nos. 1 & 2, and Landfill No. 3 area.
2. Conduct a round of measurements of ground-water levels, in situ temperatures, and conductivity during the "dry" summer season Well GC-1.	To establish seasonal groundwater variations by providing data for contrasting summer and winter measurements, specifically to define groundwater flow pattern(s) during the "dry" season as well as to qualitatively determine background groundwater conditions. (Note: a limited program has been authorized by the Air Force and is ongoing.)
3. Conduct a round of ground-water level measurements at Well GC-1 and other selected monitor wells downgradient during the peak golf course irrigation season.	To observe the impact that the golf course irrigation has on the shallow aquifer during the peak irrigation season. Although a limited program (Item 5) has been approved by the Air Force and is presently ongoing, the results are not expected to reflect a normal peak irrigation season because of the large amounts of precipitation and cooler-than-normal weather experienced this year.
4. Optional: emplace two 2-inch monitor wells using the hollow stem auger method north of Well GC-1 in the vicinity of Golf Course Road.	To confirm the presence of ground water and define the hydrogeology at the golf course between Well GC-1 and downslope Monitor Well W-13. These will help to define ground-water flow directions and water quality. Comment: If local conditions are beyond the capability of a hollow stem auger rig, then emplace one 6-inch monitor well using an air rotary rig with casing drive.
5. Sample ground water from new monitor wells and incorporate them into the monitoring program.	To incorporate new monitor wells into the monitoring program for parameters noted in Items 4 and 5.
6. Survey elevations and/or locations of any new monitor wells.	To provide accurate elevation and control data for determining ground-water flow directions.
7. Examine the septic systems at the Golf Course clubhouse and maintenance building areas.	Since this area, as well as non-base areas to the east, provide recharge to the shallow and possibly deeper aquifers, it is important to be sure that any disposal activities are environmentally sound. Base utility maps note that two septic tanks are located at the Golf Course clubhouse and one at the Golf Course maintenance building. These systems need to be examined if still in use to determine if they are still functional and in proper working order, and identify waste streams.

TABLE 6-4. GOLF COURSE RECOMMENDATIONS (continued)

Recommendation	Rationale
8. Install two deep monitor wells in the area of the golf course west of Foulois Drive.	To confirm the presence of groundwater and define the hydrogeology between the golf course area and Berman Pond. This will help define groundwater flow directions, identify any hydraulic connection between the golf course and Berman Pond area, and characterize water quality.
9. Conduct a water balance for the irrigation and precipitation at the golf course to determine the nature of any infiltration of water to underlying aquifers.	Water infiltration at the golf course can provide recharge to aquifers in the area of Landfill No. 3 and Berman Pond. Irrigation can recharge groundwater and contribute to intrusions into the disposal trenches about Landfills Nos. 3 and 4 areas. On the otherhand unnecessary irrigation could be directly recharging aquifers west of the golf course, such as around Berman Pond.
10. Conduct weekly water level measurement of the Golf Course and adjacent monitor wells over a selected year. Measurements would be taken before, during, and after the irrigation season.	These measurements will aid in determining the nature of groundwater recharge and identifying flow directions associated with irrigation at the golf course. Interpretation of these measurements will aid in determining the significance of environmental impacts, if any, due to artificial recharge via irrigation.

TABLE 6-5. BERMAN POND RECOMMENDATIONS

Recommendation	Rationale
1. Conduct chemical analyses on ground-water samples from Monitor Wells BPM-1 and 2 and Lysimeters BPL-1 and 2 as follows: 1a. Initially for Primary and Secondary drinking water standards; annually thereafter, or before initiation of remedial actions. 1b. Initially for selected organic and inorganic pollutants; annually thereafter, or before initiation of remedial actions. 1c. Initially for major anions and cations; annually thereafter, or before initiation of remedial actions.	To establish baseline ground-water quality and classification for future comparisons before remedial actions.
2. Conduct quarterly ground-water sampling for selected indicator parameters at Monitor Wells BPM-1 and 2 and Lysimeters BPL-1 and 2 along with RCRA parameters of ground-water quality and indicators of contamination.	To conduct a ground-water monitoring program on the monitor wells and lysimeters establishing seasonal and pre-remedial action ground-water quality.
3. Conduct a round of measurements of groundwater levels during the "dry" summer season at Monitor Wells BPM-1 and 2.	To establish seasonal groundwater variations by providing data for contrasting summer and winter measurements, specifically to define groundwater flow patterns(s) during the "dry" season as well as to qualitatively compare aquifer responses with the upgradient areas of the Golf Course. (Note: a limited program has been authorized by the Air Force and is ongoing.)
4. Emplace a vadose zone sampling system such as a trough and filter candles under Berman Pond.	This will aid in confirming that the pond is/or is not actively leaching and insuring that water samples collected are from directly under the pond. It will also provide correlation to the chemical constituents found in the monitor well samples and serve as a means to verify the results of any remedial actions at the pond (i.e., capping system). These would be emplaced using a drilling rig capable of drilling at low angles.
5. Conduct 12 hollow stem augerings to determine the top of the clays that underlie the pond area.	To determine the top of the clay(s) that would structurally control leachate migration, and to obtain soil samples for examination and potential chemical analyses.
6. If fluids are found in Item 7, then emplace up to 6 lysimeters.	Hollow stem augering will provide direct evidence of subsurface conditions and if free fluids are found, then lysimeters will enable sampling for chemical analysis.
7. Sample ground water from filter candle and trough system (Item 6) collection. Incorporate sampling of these systems into the monitoring program.	To incorporate new monitor wells into the IRP Phase II monitoring program.
8. Surveying elevations and/or locations of ground level control points.	To provide accurate elevation and control data.
9. Determine accurate locations and depths of all utility lines around Berman Pond.	Data required for the accurate placement and drilling of the filter candle and trough system.
10. Optional: conduct a downslope water well inventory within 1/2 mile of the base boundary.	To provide data and verify any shallow ground-water users that may be impacted by off-base migration of leachate, if any.

TABLE 6-6. CHEMICAL DISPOSAL PIT NO. 3 RECOMMENDATIONS

Recommendation	Rationale
1. Conduct chemical analyses annually on ground-water samples from all Piezometers and Lysimeters as follows: 1a. Initially for Primary and Secondary drinking water standards; annually thereafter, or before initiation of remedial actions. 1b. Initially for selected organic and inorganic pollutants; annually thereafter, or before initiation of remedial actions. 1c. Initially for major anions and cations; annually thereafter, or before initiation of remedial actions.	To establish baseline ground-water quality and classification for future comparisons before remedial actions.
2. Conduct quarterly ground-water sampling for selected indicator parameters at Piezometers P-6, P-7, and Lysimeter CP3L-3 along with RCRA parameters of ground-water quality and indicators of contamination.	To conduct a ground-water monitoring program on selected monitor wells establishing seasonal and pre-remedial action ground-water quality.
3. Conduct a round of measurements of ground-water levels, in situ temperatures, and conductivity during the "dry" summer season at Piezometer P-1 through P-10.	To establish seasonal groundwater variations, by providing data for contrasting summer and winter measurement, specifically to define groundwater flow pattern(s) during the "dry" season and to qualitatively determine waste site impacts on the groundwater. (Note: a limited program has been authorized by the Air Force and is ongoing.)
4. Examine downslope areas for slump feature identification.	Previous reports (Pashley, 1971) indicate that a portion of the South Weber Landslide complex continues under and east of the Davis-Weber Canal. The possibility exists that the slump feature is also hydraulically continuous in this same area such that contaminated ground water could migrate under and east of the Davis-Weber Canal.
5. Identify and inventory all springs and seeps on the downslope area.	The springs and seeps represent the intersection of the ground-water table with the land surface where contaminated ground water may be surfacing.
6. Collect water samples from all springs and seeps and if appropriate, Davis-Weber Canal, for chemical analyses of selected indicator parameters along with RCRA indicators of ground-water quality and contamination.	To establish if contaminated ground water is surfacing downslope.

TABLE 6-6. CHEMICAL DISPOSAL PIT NO. 3 RECOMMENDATIONS (continued)

Recommendation	Rationale
7. Emplace up to ten 2-inch piezometers/monitor wells south of the disposal area.	IRP Phase II data indicated that contaminated ground water is located outside of the present area of control. This will provide hydrogeologic data for identifying the source of the contaminants.
8. Emplace up to twenty 2-inch piezometers/monitor wells east off-base on the South Weber Landslide complex.	IRP Phase II data indicate the contaminated ground water is moving out of the present area of control. The ground-water destination is unknown. These will help to define ground-water flow directions and water quality to, under, and east of the Davis Weber Canal which is situated on the South Weber Landslide complex. Comment: Should hydrogeologic conditions exceed the capabilities of the hollow stem auger rig or a deep well is needed, then utilize an air rotary rig to emplace 2-inch or 6-inch monitor wells.
9. Sample ground water from piezometers/new monitor wells and incorporate them into the monitoring program.	To incorporate new monitor well/piezometers into IRP Phase II monitoring program for parameters noted in Items 3 and 4.
10. Review base activities upslope from Chemical Disposal Pit No. 3 to identify possible contaminant source(s).	The disposal area is situated at the convergence of the local surface drainages and possibly also of ground-water flow. Any base activities upslope (i.e., drain lines or septic tanks, or prior disposal) may have contributed to ground-water contamination.
11. Survey elevations and/or locations of monitor wells, springs, seeps, and ground-level control points.	To provide accurate elevation and control data for determining ground-water flow directions and slump feature defintiion.
12. Conduct a downslope water well inventory within 1/2 mile of the base boundary.	To provide data and verify any shallow ground-water users that may be impacted from off-base ground-water flows.
13. Optional: establish accurate elevation and location bench marks stakes in the vicinity of the disposal pit, particularly on Perimeter Road. Monitor quarterly for the first year and annually thereafter.	To provide control points to determine if active slumping is occurring. Active slumping may open or close routes of contamination flow from Chemical Disposal Pit No. 3 in addition to possible shifting of Perimeter Road along its base. Remedial action designs can then account for any slump movement.

TABLE 6-7. GENERAL RECOMMENDATIONS

Recommendation	Rationale
1. Drill and emplace selected 2-inch monitor wells with hollow stem auger.	During this investigation, it was found that the hollow stem auger could be cost effectively used in the geologic materials found at the waste sites (i.e., Berman Pond and Chemical Disposal Pit No. 3) and that satisfactory completion of shallow, smaller diameter piezometers and monitor wells could be accomplished.
2. Use open top 55-gallon barrels and lids for future collection of ground-water samples.	This will allow waste ground water to be safely containerized until chemical analyses permit the determination of the waste water final disposition.
3. Take ground water static water level measurements prior to any ground-water sampling and/or remedial actions.	To establish ground water level baseline data for assessing remedial action impacts, monitor hydraulic conditions of sampling wells and RCRA data support
4. Conduct a risk assessment as part of any follow-on activities.	Sufficient data were not available to conduct a risk assessment of the sites. A risk assessment can provide information for determining the necessity for remedial actions and for subsequent activity casting at waste sites. OEHL is developing guidelines and/or criteria for conducting risk assessments as part of IRP programs.
5. Coordinate with State agencies on shallow and/or perched aquifers not known to be used for drinking water supplies.	No regulatory guidelines and/or controls regarding these aquifers were available during this effort. Information concerning the State's regulatory view will aid in designing follow-on investigations.
6. Conduct selected groundwater pump, slug or velocity tests to determine aquifer parameters.	To establish aquifer parameters in order to estimate contaminant migration velocities for remedial action consideration. Not all waste sites are conducive to this type(s) of testing utilizing the present monitor wells.
7. In future studies use EPA Method 601 to estimate volatile halocarbon compounds rather than the TOX test.	The EPA Method 601 results were found to be more reliable than the TOX results in the Hill AFB Phase II B Survey.

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HILL AFB, UTAH
INSTALLATION RESTORATION PROGRAM
PHASE IIB IRP SURVEY
FINAL REPORT

VOLUME II: APPENDICES

TR 03-542-027

11 September 1984

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D

APPENDIX A: DEFINITIONS, NOMENCLATURE, UNITS OF MEASUREMENT AND WELL NUMBERING SYSTEM

(Well Nomenclature)

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APPENDIX A: DEFINITIONS, NOMENCLATURE, UNITS OF MEASUREMENT AND WELL NUMBERING SYSTEM

(Well Nomenclature)

(pp. A-1 through A-9)

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DEFINITIONS

AFB: Air Force Base.

AFSC: Air Force Systems Command.

AFLC: Air Force Logistics Command.

ALC: Air Logistics Center.

AQUICLUDE: Impermeable formation that impedes groundwater movement and does not yield water to a well or spring.

AQUIFER: A geologic formation, group of formations, or part of a formation that is capable of yielding water to a well or spring.

ARTESIAN: Groundwater contained under hydrostatic pressure, synonymous with confined acquifer.

AVGAS: Aviation Gasoline.

BIOACCUMULATE: Tendency of elements or compounds to accumulate or build up in the tissues of living organisms when they are exposed to these elements in their environments, e.g., heavy metals.

COD: Chemical Oxygen Demand - a measure of the amount of oxygen required to oxidize organic and oxidizable inorganic compounds in water.

CONFINED AQUIFER: An aquifer bounded above and below by impermeable beds or by beds of distinctly lower permeability than that of the aquifer itself.

CONTAMINATION: The degradation of natural water quality to the extent that its usefulness is impaired; there is no implication of any specific limits since the degree of permissible contamination depends upon the intended end use or uses of the water.

CRI: Calscience Research, Inc.

CULINARY WATER: Water used for domestic purposs as compared to water used for irrigation.

DET: Detachment.

DISPOSAL FACILITY: A facility or part of a facility at which hazardous waste is intentionally placed into or on land or water, and at which waste will remain after closure.

DISPOSAL OF HAZARDOUS WASTE: The discharge, deposit, injection, dumping, spilling, or placing of any hazardous waste into or on land or water so that such waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including groundwater.

DOD: Department of Defense.

DOWNGRADIENT: In the direction of lower hydraulic head; the direction in which groundwater flows.

DPDO: Defense Property Disposal Office.

DUMP: An uncovered land disposal site where solid and/or liquid wastes are deposited with little or no regard for pollution control or aesthetics; dumps are susceptible to open burning and are exposed to the elements, disease vectors and scavengers.

EFFLUENT: A liquid waste discharge from a manufacturing or treatment process, in its natural state, or partially or completely treated, that discharges into the environment.

EPA: Environmental Protection Agency.

EROSION: The wearing away of land surface by wind or water.

ES: Engineering-Science, Inc.

ESCARPMENT: A cliff or steep slope of some extent, generally the margin of a plateau or the steep face of an asymmetrical ridge. These may be produced by faulting, erosion or seeping of less resistant underlying stratum to create cliffy rock faces.

FACILITY: Any land and appurtenances thereon and thereto used for the treatment, storage and/or disposal of hazardous wastes.

FAULT: A surface or zone of rock formation fracture along which there has been displacement parallel to the surface of the fracture.

FPTA: Fire Protection Training Area

FLOOD PLAIN: The lowland and relatively flat areas adjoining inland and coastal areas of the mainland and off-shore islands, including, at a minimum, areas subject to a one percent or greater chance of flooding in any given year.

FLOW PATH: The direction or movement of groundwater and any contaminants that may be contained therein, as governed principally by the hydraulic gradient.

FOOT WALL: The underlying side of a fault, especially the wall rock beneath an inclined fault.

GAMMA: A gamma is the commonly used unit of magnetic intensity in the cgs electromagnetic system of units. One gamma equals 1.0×10^{-5} oersted where the oersted is the unit more familiar to physicists and engineers. The strength of the earth's magnetic field near Hill Air Force Base is approximately 0.553 oersted or 55,300 gammas. The

nanotesla (10^{-9} tesla) is a recently adopted unit equivalent to a gamma which is replacing the term gamma in much of the technical literature.

GROUNDWATER: Water beneath the land surface in the saturated zone that is under atmospheric or artesian pressure.

GROUNDWATER RESERVOIR: The earth materials and the intervening open spaces that contain groundwater.

HANGING WALL: The underlying side of a fault, or the wall rock above an inclined fault.

HARDFILL: Disposal sites receiving construction debris, wood, miscellaneous spoil material.

HAZARDOUS WASTE: A solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical or infectious characteristics may cause or significantly contribute to an increase in mortality or an increase in serious, irreversible, or incapacitating reversible illness; or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed.

HAZARDOUS WASTE GENERATION: The act or process of producing a hazardous waste.

HEAVY METALS: Metallic elements, including the transition series, which include many elements required for plant and animal nutrition in trace concentrations but which become toxic at higher concentrations.

HAFB: Hill Air Force Base, Utah.

HQ: Headquarters.

HWMF: Hazardous Waste Management Facility.

INCOMPATIBLE WASTE: A waste unsuitable for commingling with another waste or material because the commingling might result in generation of extreme heat or pressure, explosion or violent reaction, fire, formation of substances which are shock sensitive, friction sensitive, or otherwise have the potential for reacting violently, formation of toxic dusts, mists, fumes, and gases, volatilization of ignitable or toxic chemicals due to heat generation in such a manner that the likelihood of contamination of groundwater or escape of the substance into the environment is increased, any other reaction which might result in not meeting the Air, Human Health, and Environmental Standard.

INFILTRATION: The flow of liquid through pores or small openings.

IRP: Installation Restoration Program.

LANDSLIDE: A group of slope movements wherein shear fracture occurs along a specific surface or combination of surfaces, or the downward and outward movement of slope-forming materials - natural soils, artificial fills, or combinations of these materials. These can be classified as falls, slides, and/or flows.

LANDSLIDE COMPLEX: An area over which a series of different types of landslides has occurred.

LEACHATE: A solution resulting from the separation or dissolving of soluble or particulate constituents from solid waste or other man-placed medium by percolation of water.

LEACHING: The process by which soluble materials in the soil, such as nutrients, pesticide chemicals or contaminants, are washed into a lower layer of soil or are dissolved and carried away by water.

LINER: A continuous layer of natural or man-made materials beneath or on the sides of a surface impoundment, landfill, or landfill cell which restricts the downard or lateral escape of hazardous waste, hazardous waste constituents or leachate.

MONITORING WELL: A well used to measure groundwater levels and to obtain samples.

MSL: Mean Sea Level.

NANOTESLA: Unit of magnetic intensity equivalent to the gamma (see gamma).

NORMAL FAULT: A fault in which the hanging wall appears to have moved downward relative to the foot wall. The angle of the fault is usually 45-90°.

OEHL: Occupational and Environmental Health Laboratory

ORGANIC: Being, containing or relating to carbon compounds, especially in which hydrogen is attached to carbon.

PCB: Polychlorinated Biphenyls - are highly toxic to aquatic life; they persist in the environment for long periods and are biologically accumulative.

PERCOLATION: Movement of moisture, generally by gravity, through interstices of unsaturated rock or soil.

pH: Negative logarithm of hydrogen ion concentration.

PIEZOMETER: A small-diameter well in which the water level or water pressure in an aquifer can be observed.

PL: Public Law.

POL: Petroleum, Oils and Lubricants.

POLLUTANT: Any introduced gas, liquid or solid that makes a resource unfit for a specific purpose.

RCRA: Resource Conservation and Recovery Act.

RECHARGE AREA: An area in which water is absorbed that eventually reaches the zone of saturation in one or more aquifers.

RECHARGE: The addition of water to the groundwater system by natural or artificial processes.

SANITARY LANDFILL: A land disposal site using an engineered method of disposing solid wastes on land in a way that minimizes environmental hazards.

SATURATED ZONE: That part of the earth's crust in which all voids are filled with water.

SCARP: See Escarpment.

SEMI-ARTESIAN: See Semi-Confined.

SEMI-CONFINED: A completely saturated aquifer that is bounded above by a semi-pervious layer and below by a layer that is either impervious or semi-pervious. A semi-pervious layer is defined as a layer having low, though measurable, permeability relative to the acquifer.

SLIDE PLANE: A fault or surface along which a mass of earth or rock has moved downslope on a hill or mountainside.

SLIP PLANE: The planar surface along which soil or rock movement occurs during landsliding.

SLUDGE: The solid residue resulting from a manufacturing or wastewater treatment process which also produces a liquid stream.

SLUMP BLOCK: An assemblage of rock or earth of any size that has slid down from higher slopes as a unit, usually with backward rotation, on a more or less horizontal surface parallel to the cliff or slope from which it descends.

SLUMP FAULT: See Normal Fault.

SLUMP FEATURE: Physical features resulting from a slump or downward slipping of a mass of rock or unconsolidated material, including the slide plane, one or more slump blocks, etc.

SOLID WASTE: Any garbage, refuse, or sludge from a waste treatment plant, water supply treatment, or air pollution control facility and other discarded material, including solid, liquid, semi-solid, or contained gaseous material resulting from industrial, commercial, mining, or agricultural operations and from community activities, but does not include solid or dissolved materials in domestic sewage; solid or dissolved materials in irrigation return flows; industrial discharges which are point source subject to permits under Section 402 of the Federal Water Pollution Control Act, as amended (86 USC 880); or source, special nuclear, or by-product material as defined by the Atomic Energy Act of 1954 (68 USC 923).

SPILL: Any unplanned release or discharge of a hazardous waste onto or into the air, land, or water.

STORAGE OR HAZARDOUS WASTE: Containment, either on a temporary basis or for a period of years, in such a manner as not to constitute disposal of such hazardous waste.

TAC: Tactical Air Command.

TCE: Trichloroethylene - an organic solvent, also called trichloroethene.

THRUST FAULT: A fault with a dip of 45° or less over much of its extent, on which the hanging wall appears to have moved upward relative to the foot wall.

TOXICITY: The ability of a material to produce injury or disease upon exposure, ingestion, inhalation, or assimilation by a living organism.

TRANSMISSIVITY: The rate at which water is transmitted through an aquifer as a unit width under a unit hydraulic gradient.

TREATMENT OF HAZARDOUS WASTE: Any method, technique, or process including neutralization designed to change the physical, chemical, or biological character or composition of any hazardous waste so as to neutralize the waste or so as to render the waste nonhazardous.

TRICHLOROETHENE: Trichloroethylene, TCE

USAF: United States Air Force.

USDA: United States Department of Agriculture.

USDH: Utah State Department of Health.

USGS: United States Geological Survey.

VADOSE ZONE: The unsaturated zone above the water table.

WATER TABLE: Surface of a body of unconfined groundwater at which the pressure is equal to that of the atmosphere.

HILL AIR FORCE BASE IRP PHASE II
AUGER HOLE, MONITOR WELL, PIEZOMETER AND LYSIMETER NOMENCLATURE

Monitor Well, Piezometer or
Soil Sample Number

BPM-1

M - Monitor Well
P - Piezometer
L - Lysimeter
A - Auger Hole
Blank - Entire designator denotes soil sample

Study Site

CP - Chemical Disposal Pits No. 1 & 2
LF - Landfill No. 3
GC - Golf Course
BP - Berman Pond
CP3 - Chemical Disposal Pit No. 3

APPENDIX B: SCOPE OF WORK

(pp. B-1 through B-12)

B-1

APPENDIX B: SCOPE OF WORK

(pp. B-1 through B-12)

INSTALLATION RESTORATION PROGRAM
PHASE II FIELD EVALUATION
HILL AFB, UTAH

I. DESCRIPTION OF WORK.

The purpose of this task is to determine if environmental contamination has resulted from waste disposal practices at Hill AFB, Utah; to determine if hazardous chemical vapors are migrating and causing exposure of base personnel to concentrations of chemicals which are hazardous to health; to make recommendations for actions necessary to fully evaluate the magnitude and extent of contamination should contamination be found; where possible to make recommendations for site specific actions necessary to mitigate adverse environmental effects of existing contamination problems; to prioritize remedial action efforts; to suggest potential ways of restoring the environment to as near a normal level as practical; and to suggest a future environmental monitoring program to document current conditions and future discharges at sites identified at Hill AFB.

The Phase II Presurvey (Task Order 22) report incorporated background and description of the sites for this task. To accomplish this survey effort, the following steps shall be taken:

A. Review the final Phase I IRP Report (mailed under separate cover) and obtain a thorough understanding of the findings and subsequent recommendations made by the authors of the report.

B. Chemical Disposal Pits No. 1 and 2

1. Obtain all available information on the site area, to include well logs, maps, and photographs. Use this information to design a resistivity survey and monitoring program.

2. Perform an electrical resistivity (ER) survey to help map potential migration of liquid contaminants and to help determine continuity of the underlying clay layer. The ER survey will be performed as outlined in the Presurvey Report, paragraph 3.1.2.

3. Collect 21 soil cores on 50-foot centers, using a hand auger. The cores will be one foot deep, unless field reconnaissance indicates that wastes were buried deeper. Samples will be collected in glass jars and shipped to a laboratory for analysis.

4. Install 4 monitoring wells, 1 upgradient and 3 downgradient of the site. The upgradient and 2 of the downgradient wells shall be drilled to the clay layer; the remaining well shall be drilled to the first water-bearing zone below the clay layer. The wells shall be drilled and completed according to the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) standards where possible. Deviations shown in Appendix A concerning the Presurvey Report are acceptable.

*Highlights of text changes underscored

5. Collect 2 rounds of samples from the monitoring wells. One round will be taken upon completion of the monitoring wells; the other round will be taken in early spring, after period(s) of significant precipitation. Samples will be collected in appropriate containers, properly preserved, and transported to a laboratory for analysis. Sampling, preservation and shipment shall be in accordance with Appendix B of the Presurvey Report.

6. Perform a maximum of eight rounds of water level measurements from wells at this site. In addition, one round shall include all wells installed during this survey effort. The water level measurements shall be made at uniform intervals from the end of the second round of chemical sampling through November 1983 .

7. The number and type of analyses performed on soil and water samples from the site shall be as shown in Table 3-1 of the Presurvey Report, as amended by Atch 1 to this task.

C. Landfill No. 3

1. Perform a thorough review of available information on the site area. This review shall be used to design the ER survey and monitoring program.

2. Perform an ER survey to help map potential migration of liquid contaminants and to help determine continuity of the underlying clay layer. The ER survey shall be performed as outlined in the Presurvey Report, paragraph 3.3.2.

3. Install 4 monitoring wells, 2 upgradient and 2 downgradient of the site. Two of the downgradient wells shall be colocated, with one well drilled to the clay layer and the other drilled to the first water-bearing zone below the clay. The 2 upgradient wells shall be colocated, with one well drilled to the clay layer, and the other completed below the clay layer. Drilling shall be performed according to Appendix A of the Presurvey Report.

4. Collect 2 rounds of samples from the monitoring wells described above. In addition, collect 2 rounds of samples from existing monitoring wells W-6, W-7, W-8, W-9, and W-14. Sampling shall be performed according to Appendix B of the Presurvey Report.

5. The number and type of analyses performed on water samples from the site shall be as shown in Table 3-3 of the Presurvey Report, as amended by Atch 1 to this task.

D. Berman Pond

1. Review all available data, maps, and aerial photographs to determine the exact size and location of Berman Pond. Reports from geothermal and regional hydrogeological studies shall also be reviewed. These reviews shall be used to design the ER survey and monitoring program.

2. Perform an ER survey to determine the thickness of the pond and to detect any migration of contamination. The ER survey shall also be used to determine if a clay layer underlies the site. The ER survey shall be performed as outlined in the Presurvey Report, paragraph 3.4.2.

3. Collect 17 soil cores on 50-foot centers, using a hand auger. Each core shall be 5 feet in depth, unless field reconnaissance indicates that the pond was deeper. Samples shall be collected in glass jars and shipped to a laboratory for analysis.

4. Emplace 4 lysimeters within the pond area. Collect two rounds of samples from the lysimeters, one round immediately after installation, the other round after significant precipitation event(s). Perform the installation and sampling of the lysimeters as outlined in Appendix C of the Presurvey Report.

5. Install 2 monitoring wells in the Berman Pond area; well locations shall be determined upon evaluation of the results of the ER survey. The wells shall be drilled either to groundwater or a total depth of 200 feet, whichever is first encountered. Perform 2 rounds of sampling on the water obtained from the wells. Drilling and sampling procedures shall be as described in Appendices A and B of the Presurvey Report.

6. The number and types of analyses performed on water samples shall be as shown in Table 3-4 of the Presurvey Report, as amended by Atch 1 to this task. The specified analyses shown in Table 3-4 will be performed on the 17 soil cores.

E. Chemical Disposal Pit No. 3

1. Review all available information on the site, and design an ER survey and monitoring program.

2. Perform an ER survey to determine the extent of contaminant migration and to detect any underlying clay layers. The ER survey shall be performed as outlined in the Presurvey Report, paragraph 3.7.2.

3. Collect 36 soil cores on 25-foot centers, using a hand auger. The cores shall be 1 foot deep, unless field reconnaissance indicates that wastes are present below that depth. Samples shall be collected in glass jars and shipped to a laboratory for analysis.

4. Install 3 lysimeters around the pit. Collect 2 rounds of samples, one round after installation of the lysimeters and the other round after significant precipitation event(s). The lysimeters shall be installed and sampled as described in Appendix C of the Presurvey Report.

5. Install 10 borings (hollow stem auger), to groundwater (maximum of 40 feet depth each) and complete as piezometers or shallow monitor wells.

6. The number and types of analyses performed on samples from this site shall be as shown in Table 3-6 of the Presurvey Report, as amended by Atch 1 to this task.

F. Golf Course Area

1. Perform an ER survey to help map subsurface conditions in the area of the golf course.

2. Install one monitoring well in the golf course area to determine the continuity of the clay layer and characteristics of the water-bearing zones that underlie the area. Complete the well according to the amended Presurvey Report.

3. Collect 2 rounds of samples from the monitoring well described above. Analyze according to Appendix E of the Presurvey Report, as amended by Atch 1 to this task .

G. Safety Program

Develop a comprehensive Safety Program prior to initiation of field work. The program shall consider all potential hazards to field and Hill AFB personnel. The Safety Program shall be presented to Hill AFB safety personnel for their review. If necessary, a meeting may be held at Hill AFB prior to initiation of field work to discuss the program.

H. Cleanup (by contractor personnel)

Well, boring, and lysimeter locations shall be cleaned following the completion of installation, by the removal of cuttings and general policing of the area.

I. Report Preparation

Prepare a report delineating the findings of this field investigation. This report shall include formal recommendations for any additional field investigations necessary at Hill AFB. To the maximum extent possible, magnitude and extent of environmental contamination should be reported. The contractor shall use best engineering judgement to evaluate the significance of the contamination. Recommendations for future environmental monitoring shall be included; "monitor only" should be evaluated as an alternative to clean-up at each site.

J. Data Review

Results of the first round of sampling and analysis shall be tabulated and forwarded to the USAF OEHL for review as soon as they become available as specified in Item VI below.

K. Report Review

A draft report delineating all findings and recommendations shall be prepared and forwarded to the USAF OEHL as specified in Item VI below for Air Force review and comment. If necessary, a report review meeting may be held at UBTL to discuss the draft report and to recommend changes to be incorporated into the final report.

II. SITE LOCATION AND DATES:

Hill AFB UT
Building 242
To be established

III. BASE SUPPORT: None

IV. GOVERNMENT FURNISHED PROPERTY: 2 copies of Phase II Presurvey Report, referenced in Item I.

V. GOVERNMENT TECHNICAL POINT OF CONTACT:

1. Dr Dee Ann Sanders
USAF OEHL/ECW
Brooks AFB TX 78235
(512) 536-3305

2. Lt Col Maynard G. Moody
USAF Hospital/SGB
Hill AFB UT 84056
(801) 777-4551

VI. In addition to sequences 1, 5 and 11 which are listed in Attachment 1 to the contract, and are applicable to all contracts, the sequence number listed below is applicable. Also shown are data applicable to this order:

Sequence No.	Block 10	Block 11	Block 12	Block 13	Block 14
3	OTIME	*			
3	OTIME	**			
4	ONE/R	30 Sep 83	30 Sep 83	31 Dec 83	***

* Upon completion of sample analyses
** Upon completion of field monitoring
*** 15 copies of the draft final report will be required.

ATTACHMENT 1. SUMMARY OF CHEMICAL ANALYSES.

Water Analysis	Chem. Pits Nos. 1 & 2 I	II	Total	Landfill No. 3 I	II	Total	Golf Course Area I	II	Total	Berman Pond I	II	Total	Chem. Pit No. 3 I	II	Total	Total Analyzed
TOC	4	4	8	6	6	12	1	1	2	5	5	10	11	13	24	56
TOX	4	0	4	6	0	6	1	0	1	5	0	5	11	0	11	27
Oil & Grease	4	4	8	5	6	11	1	1	2	3	3	6	0	0	0	27
Phenol	4	4	8	5	6	11	1	1	2	4	3	7	0	10	10	38
MBAS	0	0	0	6	6	12	1	1	2	0	0	0	0	0	0	14
TDS	2	2	4	7	6	13	1	5	6	0	0	0	0	0	0	23
Cyanide	0	0	0	5	6	11	1	1	2	3	3	6	11	12	23	42
Sulfate	2	2	4	8	6	14	1	5	6	0	0	0	0	0	0	24
Arsenic	0	0	0	5	6	11	1	1	2	0	0	0	0	0	0	13
Barium	0	4	4	0	6	6	0	5	5	0	5	5	0	13	13	33
Beryllium	0	0	0	5	6	11	1	1	2	5	5	10	11	13	24	47
Cadmium	0	4	4	5	6	11	1	4	5	5	5	10	11	13	24	54
Chromium	0	0	0	5	6	11	1	1	2	5	5	10	11	13	24	47
Copper	0	0	0	5	6	11	1	1	2	0	0	0	0	0	0	13
Iron	2	4	6	7	6	13	1	5	6	0	5	5	0	13	13	43
Lead	0	0	0	5	6	11	1	1	2	0	0	0	0	0	0	13
Manganese	2	4	6	7	6	13	1	5	6	0	5	5	0	13	13	43
Mercury	0	0	0	5	6	11	1	1	2	0	0	0	0	0	0	13
Zinc	0	4	4	0	6	6	0	5	5	0	5	5	0	13	13	33
601 (6 analytes)	4	0	4	6	0	6	1	0	1	5	0	5	11	0	11	27
601 (29 analytes)	0	4	4	0	6	6	0	1	1	0	4	4	0	13	13	28
602 (6 analytes)	4	4	8	6	6	12	1	1	2	4	4	8	0	0	0	30
GC/MS	1	0	1	2	0	2	0	0	0	2	0	2	0	0	0	6*
ICAP	1	0	1	2	0	2	0	0	0	2	0	2	0	0	0	5
Conductivity	4	4	8	5	6	11	1	5	6	2	5	7	11	13	24	56
Calcium	2	4	6	4	6	10	1	5	6	0	5	5	0	13	13	40
Magnesium	2	4	6	4	6	10	1	5	6	0	5	5	0	13	13	40
Sodium	2	2	4	4	4	8	1	5	6	0	0	0	0	0	0	18
Potassium	2	2	4	4	4	8	1	5	6	0	0	0	0	0	0	18
Carbonate	2	2	4	4	4	8	1	5	6	0	0	0	0	0	0	18
Bicarbonate	2	2	4	4	4	8	1	5	6	0	0	0	0	0	0	18
Chloride	2	2	4	4	4	8	1	5	6	0	0	0	0	0	0	18
Fluoride	2	2	4	4	4	8	1	5	6	0	0	0	0	0	0	18
Nitrate	2	2	4	4	4	8	1	5	6	0	0	0	0	0	0	18
Hardness	2	2	4	4	4	8	1	5	6	0	0	0	0	0	0	18
Silica	2	2	4	4	4	8	1	5	6	0	0	0	0	0	0	18

Soil Analysis	Chem. Pits Nos. 1 & 2 I	II	Total	Landfill No. 3 I	II	Total	Golf Course Area I	II	Total	Berman Pond I	II	Total	Chem. Pit No. 3 I	II	Total	Total Analyzed
TOC	21	0	21	0	0	0	0	0	0	17	0	17	36	0	36	74
TOX	21	0	21	0	0	0	0	0	0	17	0	17	36	0	36	74
Oil & Grease	21	0	21	0	0	0	0	0	0	17	0	17	0	0	0	38
Phenol	0	0	0	0	0	0	0	0	0	17	0	17	0	0	0	38
Cyanide	0	0	0	0	0	0	0	0	0	17	0	17	36	0	36	53
Beryllium	0	0	0	0	0	0	0	0	0	17	0	17	36	0	36	53
Cadmium	0	0	0	0	0	0	0	0	0	17	0	17	36	0	36	53
Chromium	0	0	0	0	0	0	0	0	0	17	0	17	36	0	36	53
Moisture	21	0	21	0	0	0	0	0	0	17	0	17	36	0	36	74

*Note: An additional GC/MS sample from Base Well No. 4 was also processed.

INSTALLATION RESTORATION PROGRAM
PHASE II FIELD EVALUATION
HILL AFB, UTAH

I. DESCRIPTION OF WORK.

The purpose of this task is to determine if environmental contamination has resulted from waste disposal practices at Hill AFB, Utah; to determine if hazardous chemical vapors are migrating and causing exposure of base personnel to concentrations of chemicals which are hazardous to health; to make recommendations for actions necessary to fully evaluate the magnitude and extent of contamination should contamination be found; where possible to make recommendations for site specific actions necessary to mitigate adverse environmental effects of existing contamination problems; to prioritize remedial action efforts; to suggest potential ways of restoring the environment to as near a normal level as practical; and to suggest a future environmental monitoring program to document current conditions and future discharges at sites identified at Hill AFB.

The Phase II Presurvey (Task Order 22) report incorporated background and description of the sites for this task. To accomplish this survey effort, the following steps shall be taken:

A. Review the final Phase I IRP Report (mailed under separate cover) and obtain a thorough understanding of the findings and subsequent recommendations made by the authors of the report.

B. Chemical Disposal Pits No. 1 and 2

1. Obtain all available information on the site area, to include well logs, maps, and photographs. Use this information to design a resistivity survey and monitoring program.

2. Perform an electrical resistivity (ER) survey to help map potential migration of liquid contaminants and to help determine continuity of the underlying clay layer. The ER survey will be performed as outlined in the Presurvey Report, paragraph 3.1.2.

3. Collect 21 soil cores on 50-foot centers, using a hand auger. The cores will be one foot deep, unless field reconnaissance indicates that wastes were buried deeper. Samples will be collected in glass jars and shipped to a laboratory for analysis.

4. Install 4 monitoring wells, 1 upgradient and 3 downgradient of the site. The upgradient and 2 of the downgradient wells shall be drilled to the clay layer; the remaining well shall be drilled to the first water-bearing zone below the clay layer. The wells shall be drilled and completed according to the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) standards where possible. Deviations shown in Appendix A concerning the Presurvey Report are acceptable.

*Highlights of text changes underscored

5. Collect 2 rounds of samples from the monitoring wells. One round will be taken upon completion of the monitoring wells; the other round will be taken in early spring, after period(s) of significant precipitation. Samples will be collected in appropriate containers, properly preserved, and transported to a laboratory for analysis. Sampling, preservation and shipment shall be in accordance with Appendix B of the Presurvey Report.

6. Perform a maximum of eight rounds of water level measurements from wells at this site. In addition, one round shall include all wells installed during this survey effort. The water level measurements shall be made at uniform intervals from the end of the second round of chemical sampling through November 1983.

7. The number and type of analyses performed on soil and water samples from the site shall be as shown in Table 3-1 of the Presurvey Report, as amended by Atch 1 to this task.

C. Landfill No. 3

1. Perform a thorough review of available information on the site area. This review shall be used to design the ER survey and monitoring program.

2. Perform an ER survey to help map potential migration of liquid contaminants and to help determine continuity of the underlying clay layer. The ER survey shall be performed as outlined in the Presurvey Report, paragraph 3.3.2.

3. Install 4 monitoring wells, 2 upgradient and 2 downgradient of the site. Two of the downgradient wells shall be colocated, with one well drilled to the clay layer and the other drilled to the first water-bearing zone below the clay. The 2 upgradient wells shall be colocated, with one well drilled to the clay layer, and the other completed below the clay layer. Drilling shall be performed according to Appendix A of the Presurvey Report.

4. Collect 2 rounds of samples from the monitoring wells described above. In addition, collect 2 rounds of samples from existing monitoring wells W-6, W-7, W-8, W-9, and W-14. Sampling shall be performed according to Appendix B of the Presurvey Report.

5. The number and type of analyses performed on water samples from the site shall be as shown in Table 3-3 of the Presurvey Report, as amended by Atch 1 to this task.

D. Berman Pond

1. Review all available data, maps, and aerial photographs to determine the exact size and location of Berman Pond. Reports from geothermal and regional hydrogeological studies shall also be reviewed. These reviews shall be used to design the ER survey and monitoring program.

2. Perform an ER survey to determine the thickness of the pond and to detect any migration of contamination. The ER survey shall also be used to determine if a clay layer underlies the site. The ER survey shall be performed as outlined in the Presurvey Report, paragraph 3.4.2.

3. Collect 17 soil cores on 50-foot centers, using a hand auger. Each core shall be 5 feet in depth, unless field reconnaissance indicates that the pond was deeper. Samples shall be collected in glass jars and shipped to a laboratory for analysis.

4. Emplace 4 lysimeters within the pond area. Collect two rounds of samples from the lysimeters, one round immediately after installation, the other round after significant precipitation event(s). Perform the installation and sampling of the lysimeters as outlined in Appendix C of the Presurvey Report.

5. Install 2 monitoring wells in the Berman Pond area; well locations shall be determined upon evaluation of the results of the ER survey. The wells shall be drilled either to groundwater or a total depth of 200 feet, whichever is first encountered. Perform 2 rounds of sampling on the water obtained from the wells. Drilling and sampling procedures shall be as described in Appendices A and B of the Presurvey Report.

6. The number and types of analyses performed on water samples shall be as shown in Table 3-4 of the Presurvey Report, as amended by Atch 1 to this task. The specified analyses shown in Table 3-4 will be performed on the 17 soil cores.

E. Chemical Disposal Pit No. 3

1. Review all available information on the site, and design an ER survey and monitoring program.

2. Perform an ER survey to determine the extent of contaminant migration and to detect any underlying clay layers. The ER survey shall be performed as outlined in the Presurvey Report, paragraph 3.7.2.

3. Collect 36 soil cores on 25-foot centers, using a hand auger. The cores shall be 1 foot deep, unless field reconnaissance indicates that wastes are present below that depth. Samples shall be collected in glass jars and shipped to a laboratory for analysis.

4. Install 3 lysimeters around the pit. Collect 2 rounds of samples, one round after installation of the lysimeters and the other round after significant precipitation event(s). The lysimeters shall be installed and sampled as described in Appendix C of the Presurvey Report.

5. Install 10 borings (hollow stem auger), to groundwater (maximum of 40 feet depth each) and complete as piezometers or shallow monitor wells.

6. The number and types of analyses performed on samples from this site shall be as shown in Table 3-6 of the Presurvey Report, as amended by Atch 1 to this task.

F. Golf Course Area

1. Perform an ER survey to help map subsurface conditions in the area of the golf course.

2. Install one monitoring well in the golf course area to determine the continuity of the clay layer and characteristics of the water-bearing zones that underlie the area. Complete the well according to the amended Presurvey Report.

3. Collect 2 rounds of samples from the monitoring well described above. Analyze according to Appendix E of the Presurvey Report, as amended by Atch 1 to this task.

G. Safety Program

Develop a comprehensive Safety Program prior to initiation of field work. The program shall consider all potential hazards to field and Hill AFB personnel. The Safety Program shall be presented to Hill AFB safety personnel for their review. If necessary, a meeting may be held at Hill AFB prior to initiation of field work to discuss the program.

H. Cleanup (by contractor personnel)

Well, boring, and lysimeter locations shall be cleaned following the completion of installation, by the removal of cuttings and general policing of the area.

I. Report Preparation

Prepare a report delineating the findings of this field investigation. This report shall include formal recommendations for any additional field investigations necessary at Hill AFB. To the maximum extent possible, magnitude and extent of environmental contamination should be reported. The contractor shall use best engineering judgement to evaluate the significance of the contamination. Recommendations for future environmental monitoring shall be included; "monitor only" should be evaluated as an alternative to clean-up at each site.

J. Data Review

Results of the first round of sampling and analysis shall be tabulated and forwarded to the USAF OEHL for review as soon as they become available as specified in Item VI below.

K. Report Review

A draft report delineating all findings and recommendations shall be prepared and forwarded to the USAF OEHL as specified in Item VI below for Air Force review and comment. If necessary, a report review meeting may be held at UBTL to discuss the draft report and to recommend changes to be incorporated into the final report.

II. SITE LOCATION AND DATES:

Hill AFB UT
Building 242
To be established

III. BASE SUPPORT: None

IV. GOVERNMENT FURNISHED PROPERTY: 2 copies of Phase II Presurvey Report, referenced in Item I.

V. GOVERNMENT TECHNICAL POINT OF CONTACT:

1. Dr Dee Ann Sanders
USAF OEHL/ECW
Brooks AFB TX 78235
(512) 536-3305

2. Lt Col Maynard G. Moody
USAF Hospital/SGB
Hill AFB UT 84056
(801) 777-4551

VI. In addition to sequences 1, 5 and 11 which are listed in Attachment 1 to the contract, and are applicable to all contracts, the sequence number listed below is applicable. Also shown are data applicable to this order:

Sequence No.	Block 10	Block 11	Block 12	Block 13	Block 14
3	OTIME	*			
3	OTIME	**			
4	ONE/R	83SEP30	83SEP30	83DEC31	***

* Upon completion of sample analyses
** Upon completion of field monitoring
*** 15 copies of the draft final report will be required.

ATTACHMENT 1. SUMMARY OF CHEMICAL ANALYSES.

Water Analysis	Chem. Pits Nos. 1 & 2 I	II	Total	Landfill No. 3 I	II	Total	Golf Course Area I	II	Total	Berman Pond I	II	Total	Chem. Pit No. 3 I	II	Total	Total Analyzed
TOC	4	4	8	6	6	12	1	1	2	5	5	10	11	13	24	36
TOX	4	0	4	6	0	6	1	0	1	5	0	5	11	0	11	27
Oil & Grease	4	4	8	5	6	11	1	1	2	3	3	6	0	0	0	27
Phenol	4	4	8	5	6	11	1	1	2	4	3	7	0	10	10	38
MBAS	0	0	0	6	6	12	1	1	2	0	0	0	0	0	0	14
TDS	2	2	4	7	6	13	1	5	6	0	0	0	0	0	0	23
Cyanide	0	0	0	5	6	11	1	1	2	3	3	6	11	12	23	42
Sulfate	2	2	4	8	6	14	1	5	6	0	0	0	0	0	0	24
Arsenic	0	0	0	5	6	11	1	1	2	0	0	0	0	0	0	13
Barium	0	4	4	0	6	6	0	5	5	0	5	5	0	13	13	33
Beryllium	0	0	0	5	6	11	1	1	2	5	5	10	11	13	24	47
Cadmium	0	4	4	5	6	11	1	4	5	5	5	10	11	13	24	54
Chromium	0	0	0	5	6	11	1	1	2	5	5	10	11	13	24	47
Copper	0	0	0	5	6	11	1	1	2	0	0	0	0	0	0	13
Iron	2	4	6	7	6	13	1	5	6	0	5	5	0	13	13	43
Lead	0	0	0	5	6	11	1	1	2	0	0	0	0	0	0	13
Manganese	2	4	6	7	6	13	1	5	6	0	5	5	0	13	13	43
Mercury	0	0	0	5	6	11	1	1	2	0	0	0	0	0	0	13
Zinc	0	4	4	0	6	6	0	5	5	0	5	5	0	13	13	33
601 (6 analytes)	4	0	4	6	0	6	1	0	1	5	0	5	11	0	11	27
601 (29 analytes)	0	4	4	0	6	6	0	1	1	0	4	4	0	13	13	28
602 (6 analytes)	4	4	8	6	6	12	1	1	2	4	4	8	0	0	0	30
GC/MS	1	0	1	2	0	2	0	0	0	2	0	2	0	0	0	6*
ICAP	1	0	1	2	0	2	0	0	0	2	0	2	0	0	0	5
Conductivity	4	4	8	5	6	11	1	5	6	2	5	7	11	13	24	56
Calcium	2	4	6	4	6	10	1	5	6	0	5	5	0	13	13	40
Magnesium	2	4	6	4	6	10	1	5	6	0	5	5	0	13	13	40
Sodium	2	2	4	4	4	8	1	5	6	0	0	0	0	0	0	18
Potassium	2	2	4	4	4	8	1	5	6	0	0	0	0	0	0	18
Carbonate	2	2	4	4	4	8	1	5	6	0	0	0	0	0	0	18
Bicarbonate	2	2	4	4	4	8	1	5	6	0	0	0	0	0	0	18
Chloride	2	2	4	4	4	8	1	5	6	0	0	0	0	0	0	18
Fluoride	2	2	4	4	4	8	1	5	6	0	0	0	0	0	0	18
Nitrate	2	2	4	4	4	8	1	5	6	0	0	0	0	0	0	18
Hardness	2	2	4	4	4	8	1	5	6	0	0	0	0	0	0	18
Silica	2	2	4	4	4	8	1	5	6	0	0	0	0	0	0	18

Soil Analysis	Chem. Pits Nos. 1 & 2 I	II	Total	Landfill No. 3 I	II	Total	Golf Course Area I	II	Total	Berman Pond I	II	Total	Chem. Pit No. 3 I	II	Total	Total Analyzed
TOC	21	0	21	0	0	0	0	0	0	17	0	17	36	0	36	74
TOX	21	0	21	0	0	0	0	0	0	17	0	17	36	0	36	74
Oil & Grease	21	0	21	0	0	0	0	0	0	17	0	17	0	0	0	38
Phenol	0	0	0	0	0	0	0	0	0	17	0	17	0	0	0	38
Cyanide	0	0	0	0	0	0	0	0	0	17	0	17	36	0	36	53
Beryllium	0	0	0	0	0	0	0	0	0	17	0	17	36	0	36	53
Cadmium	0	0	0	0	0	0	0	0	0	17	0	17	36	0	36	53
Chromium	0	0	0	0	0	0	0	0	0	17	0	17	36	0	36	53
Moisture	21	0	21	0	0	0	0	0	0	17	0	17	36	0	36	74

*Note: An additional GC/MS sample from Base Well No. 4 was also processed.

APPENDIX C: WELL COMPLETION AND GEOLOGICAL DRILLING LOGS
(WELL AND GEOLOGIC LOGS) FOR

- Chemical Disposal Pits Nos. 1 and 2 Field Sample Descriptions
- Chemical Disposal Pits Nos. 1 and 2, Landfill No. 3 Phase II RIP Monitor Well Field Sample Descriptions
- Berman Pond Field Sample Descriptions
- Golf Course Well Field Sample Descriptions
- Chemical Disposal Pit No. 3 Field Sample Descriptions
- IRP Phase II Monitor Well and Piezometer Completion Logs
- U.S. Army Corps of Engineers Soil Description Vicinity of Berman Pond
- U.S. Army Corps of Engineers Soil Borings Exhibit E & F Vicinity of Berman Pond
- Hill AFB "80" Series Monitor Well Geologic Logs (Peterson Bros. Drilling Co.)
- Hill AFB "80" Series Monitor Well Casing Depths (Peterson Bros. Drilling Co.)
- Hill AFB "W" Series Monitor Well Geologic Logs

(pp. C-1 through C-134)

APPENDIX C: WELL COMPLETION AND GEOLOGICAL DRILLING LOGS (WELL AND GEOLOGIC LOGS) FOR

- Chemical Disposal Pits Nos. 1 and 2 Field Sample Descriptions
- Chemical Disposal Pits Nos. 1 and 2, Landfill No. 3 Phase II RIP Monitor Well Field Sample Descriptions
- Berman Pond Field Sample Descriptions
- Golf Course Well Field Sample Descriptions
- Chemical Disposal Pit No. 3 Field Sample Descriptions
- IRP Phase II Monitor Well and Piezometer Completion Logs
- U.S. Army Corps of Engineers Soil Description Vicinity of Berman Pond
- U.S. Army Corps of Engineers Soil Borings Exhibit E & F Vicinity of Berman Pond
- Hill AFB "80" Series Monitor Well Geologic Logs (Peterson Bros. Drilling Co.)
- Hill AFB "80" Series Monitor Well Casing Depths (Peterson Bros. Drilling Co.)
- Hill AFB "W" Series Monitor Well Geologic Logs

(pp. C-1 through C-134)

RADIAN CORPORATION

TABLE OF CHEMICAL DISPOSAL PITS 1 AND 2
FIELD SAMPLE DESCRIPTIONS

Location Designation	Depth (Feet)	Sample Description
CP-1	0-1.5 TD*	Gravel, sand, brown, unconsolidated. (Hand augered)
CP-2	0-0.5	Sand, gravel, pebbles, very dark grey, almost black. (Hand augered)
	0.5-1.0 TD	Sand, gravel, black, appears soaked with hydrocarbon material. (Hand augered)
CP-3	0-0.5 TD	Sand, gravel, black, hydrocarbon odor. (Hand augered)
CP-4	0-1.0 +	Sand, gravel, tan.
	1.0~1.7 TD	Sand, gravel, black, hydrocarbon odor. (Hand augered)
CP-5	0-0.8	Soil, sand, brown, damp, unconsolidated.
	0.8-1.1 TD	Sludge, soil, dry, unconsolidated. Distinct contact from above material. (Hand augered)
CP-6	0-1.0	Gravel, pebbles, sand, brown, unconsolidated.
	1.0-1.3 TD	Sludge, black, dry. (Hand augered)
CP-7	0-0.5	Soil, sandy, brown unconsolidated.
	0.5-0.7 TD	Sludge, gravel, sand, black, dry, semi-consolidated. (Hand augered)
CP-8	0-0.8	Soil, sandy, brown, unconsolidated.
	0.8-0.9 TD	Sludge, black, dry, semi-consolidated. (Hand augered)

(Continued)

NOTE: * Denotes total depth, hand augered.

(CHEMICAL DISPOSAL PITS 1 AND 2 FIELD SAMPLE DESCRIPTIONS - continued)

Location Designation	Depth (Feet)	Sample Description
CP-9	0-0.6	Soil, sand brown.
	0.6-0.8	Sludge, black, dry and flakey.
		(Hand augered)
CP-10	0-0.3	Soil, sandy, brown, unconsolidated.
	0.3-0.4	Sludge, dry, flaky.
	0.4-0.9 TD	Gravel, sand, brown, marbled with sludge.
		(Hand augered)
CP-11	0-0.3	Soil, sandy, brown, unconsolidated.
	0.3-0.5	Sludge, black, pebble, gravel, unconsolidated.
	0.5-0.8 TD	Pebbles, sand, gravel, brown, unconsolidated.
		(Hand augered)
CP-12	0-2.0 TD	Pebbles, gravels, sand, brown, unconsolidated.
		(Hand augered)
CP-13	0-0.8	Soil, sandy, brown, unconsolidated.
	~0.8	Metal, very rusted.
	0.8-1.1	Pebbles, gravel, sand, brown, unconsolidated.
	1.1-1.5 TD	Pebbles, gravel, sand, greyish tan, unconsolidated.
		(Hand augered)
CP-14	0-0.2	Soil, sandy, brown, unconsolidated.
	0.2-0.4	Sludge, black.
	0.4-0.8 TD	Gravel, sand, brown, unconsolidated.
		(Hand augered)
CP-15	0-0.3	Soil, sandy, tan, unconsolidated.
	0.3-1.1 TD	Sludge, black, pasty, strong hydrocarbon odor when broken.
		(Hand augered)
CP-16	0-1.8 TD	Soil, sandy, gravel, pebbles, brown, unconsolidated.
		(Hand augered)

(Continued)

(CHEMICAL DISPOSAL PITS 1 AND 2 FIELD SAMPLE DESCRIPTIONS - continued)

Location Designation	Depth (Feet)	Sample Description
CP-17	0-1.0	Soil, sand, gravel, pebbles, brown, unconsolidated.
	0.7	Seep of water.
	1.0-1.4 TD	Sludge, black, water seep on top of sludge, strong hydrocarbon odor (like shoe polish).
CP-18	0-0.6	Soil, sand, gravel, pebbles, brown, unconsolidated.
	0.6-1.4 TD	Sand, gravel, pebbles, tan, unconsolidated.
		(Hand augered)
CP-19	0-0.7	Soil, sand, gravel, pebbles, brown, unconsolidated.
	0.7-1.1 TD	Sludge, black, dry weathered appearance.
		(Hand augered)
CP-20	0-0.4	Soil, sandy, brown, unconsolidated.
	0.4-0.8 TD	Sludge, black, dry, some hydrocarbon odor.
		(Hand augered)

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TABLE OF LANDFILL 3, CHEMICAL DISPOSAL PITS 1 AND 2 PHASE II IRP
MONITOR WELL FIELD SAMPLE DESCRIPTIONS

Location Designation	Depth (Feet)	Sample Description
M-1	0-11	Sand, gravel, unconsolidated.
	13-18	Silt, sand, gravel, brown, unconsolidated.
	18-21	Silt, sand, very fine, tan, unconsolidated.
	21-22	Silt, sand, very fine, unconsolidated.
	27-32	Gravel, sand, unconsolidated, ∿30 feet water.
	32-33 TD*	Clay, reddish brown.
		(Air rotary drilled)
M-2	0-2	Soil, sandy, brown, unconsolidated.
	2-10	Sand, silt, gravel, tan, gravel is angular, unconsolidated.
	10-17	Sand, gravel, pebbles, brown, slight moisture, unconsolidated.
	17-20	Gravel, sand, coarse, damp, unconsolidated.
	20-26	Sand, gravel, brown, damp, unconsolidated.
	26-30	Gravel, sand, more damp (capillary zone ?), unconsolidated, ∿29 feet water.
	30-33 TD	Clay, reddish brown.
		(Air rotary drilled)
M-3	0-10	Sand, silt, minor gravel, tan, unconsolidated.
	10-11	Gravel, white, fine, very angular and hard drilling powdery cuttings.
	11-32	Sands, silts, gravel, tan, unconsolidated.
	∿26½	Gravel, coarse, tan, angular.
	∿29	-- cuttings moist.
	∿30	-- water.
	32-92 TD	Clay, brown plastic.
	49 est.	Clay changes from solid clay below 32 feet to a clay interbedded with silts and very fine sands difficult to define contact, if any.
	∿60	Driller noted very small amounts of water being produced during drilling from about this level.
		(Air rotary drilled)

(Continued)

NOTE: * Denotes total depth air rotary drilled.

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(MONITOR WELL FIELD SAMPLE DESCRIPTION - continued)

Location Designation	Depth (Feet)	Sample Description
M-4	0-2	Soil, sand, unconsolidated.
	2-9	Gravel, sand, pebbles, tan, unconsolidated.
	9-16	Sand, fine to very coarse, tan, unconsolidated.
	16-17	Gravel, coarse, tan, unconsolidated.
	18-25	Sand, gravel, angular, tan, unconsolidated, little water ∿25 feet.
	25-27½ TD	Clay, grey and reddish brown, plastic.
		(Air rotary drilled)
M-6	0-2	Soil, sandy, brown, unconsolidated.
	2-6	Sand, gravel, silt, tan, unconsolidated.
	6-8	Silt, sand, gravel.
	8-22	Silt, sand very fine, gravel, light tan, damp @ ∿16 feet, unconsolidated.
	22-23	Sand, gravel, wet, unconsolidated.
	23-35 est.	Clay, sandy, brown, contact with lower zones appears transitional and was inferred from open hole failure.
	35-77 TD	Clay, sand and silt interbedded, samples appear to get silty and sandier with depth, greyish-brown.
		(Air rotary drilled)
M-7	0-1	Soil, sand, gravel, unconsolidated.
	1-4	Sand.
	4-17	Gravel, sand, silt, very damp ∿16 feet, unconsolidated.
	17-18	Clay, silty, brown.
	18-25 TD	Clay, silty, grey.
		(Air rotary drilled)
M-9	0-7	Gravel, sand, clay, tannish brown.
	7-10	Clay, brown, moist ∿7 feet but no free water.
	10-15 TD	Clay, grey.
		(Air rotary drilled)

(Continued)

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(MONITOR WELL FIELD SAMPLE DESCRIPTION - continued)

Location Designation	Depth (Feet)	Sample Description
M-10	0-8	Gravel.
	8-13	Clay, moist.
	13-31	Clay, mushy @ $\sim$13-15 feet.
	31-34 TD	Sand and water.
		(Air rotary drilled)

TABLE OF BERMAN POND FIELD SAMPLE DESCRIPTIONS

Location Designation	Depth (Feet)	Sample Description
BP-11	0-1.5	Soil, brown unconsolidated sandy loam.
	1.5-2.5	Pebbles, gravel, rounded, unconsolidated.
	2.5-3.0	Tar sludge (?), pebbles, gravels, black and hard.
	3.0-3.5 TD*	Sludge (?), sand, black.
		(Hand augered)
BP-15	0-3.5	Fill material, asphalt chunks, pebbles, gravel, very dark brown/black, unconsolidated
		(Hand augered)
	3.5-5.0 TD	Sandy loam, brown, some moisture, slight odor.
		(Hand augered)
BP-17	0-5.0 TD	Sand, tan, fine, unconsolidated.
	3.5	Sand, dark, moist appearance.
		(Hand augered)
BP-28 (L-3)[1]	0-5.0	Sand, tan and brown, fine to very fine, unconsolidated.
	5.0-6.0	Sand, tan and brown, fine to very fine, unconsolidated.
	6.0-15.0	Sand, tan and brown.
	15.0-15.8	Sand, tan, fine to very fine, unconsolidated. (Split spoon sample)
	15.8-15.9 TD	Clay, brown, plastic (Split spoon sample).
		(Hollow stem augered)
BP-38	0-5.0 TD	Sand, brown and tan, very fine, unconsolidated.
		(Hand augered)

(Continued)

NOTE: * Denotes total depth, hand, hollow stem augered, or air rotary drilled.
[1] Parentheses indicate number of lysimeter emplaced in auger hole.

(BERMAN POND FIELD SAMPLE DESCRIPTION - continued)

Location Designation	Depth (Feet)	Sample Description
BP-58	0-5.0	Sand, brown, fine grained, unconsolidated.
(L-4)	5.0-5.4	Silt stone (?), light grey, consolidated. (Split spoon sample)
	5.4-6.5	Sand, brown, fine to very fine grained, unconsolidated.
	6.5-15.0	Sand, brown, fine to very fine grained, unconsolidated.
	15.0-16.0 TD	Sand, brown, fine to very fine grained, unconsolidated.
		(Hollow stem augered)
BP-75	0-5	Sand, gravel, dark brown, damp, unconsolidated.
	5+	-- (Split spoon sample.)
	5-15	Sand, tannish brown, unconsolidated.
	15+ TD	-- (Split spoon sample.)
		(Hollow stem augered)
BP-77	0-5	Gravel, sand, brown, unconsolidated.
(L-2)	5+	-- (Split spoon sample)
	5-11	Sand, gravel, tannish brown, unconsolidated.
	11-15	Sand, minor gravel, tannish brown, unconsolidated.
	15+ TD	-- (Split spoon sample)
		(Hollow stem augered)
BP-110	0-5.0 TD	Sand, tan, very fine, unconsolidated.
		(Hand augered)
BP-111	1.0-3.0	Soil, damp and sandy.
(L-1)	3.0-6.5	Sand
	6.5-7.0	Sand, damp, some clay, slightly plastic and sticky.
	7.0-10.0	Sand
	10.0-11.0	Sand, clay, damp
	11.0-12.5 TD	Sand
		(Hand augered)

(Continued)

(BERMAN POND FIELD SAMPLE DESCRIPTION - continued)

Location Designation	Depth (Feet)	Sample Description
BP-311	0-5.5 TD	Sand, brown, fine to very fine, unconsolidated.
		(Hand augered)
BPM-1	0-1	Topsoil, almost black.
	1-26	Sand, brown, fine grained.
	26-41	Clay, brown, plastic.
	41-86	Sand, minor silt, very fine grained, unconsolidated, drilling got harder with clayey/silty returns from ∿60-66 feet.
	86-95	Clay, minor gravel, brown, some moisture.
	95-101	Clay, silty/sandy, brown.
	101-122½ TD	Sand, silt, very fine; moisture increases @ ∿105 feet, and @ ∿116 feet hit "free water".
		(Air rotary drilled)
BPM-2	0-6	Sand, brown, fine to very fine, unconsolidated.
	∿6	Clay, sandy, brown; stringer.
	6-12	Sand with clay stringers, brown, fine to very fine.
	12-23	Sand, brown, fine to very fine.
	23-31	Clay, brown, plastic, sand stringers.
	31-47	Sand, tan, fine to very fine, unconsolidated.
	47-50	Clay and silts, brown, plastic.
	50-52	Clay, silty, brown, plastic, moist (?).
	52-57	Sand.
	57-58	Clay, silty, brown, plastic.
	58-72	Clay, sands, brown; interbedded clays and sands.
	72-73 (?)	Clay, hard.
	73(?)-80	Sand, fine to very fine, unconsolidated, moist.
	80-83	Clay.
	83-84	Sand, brown, fine to very fine, wet and heaving inside casing.
	84-88	Sand, medium to fine.
	88-91 TD	Sand, gravel, coarse to fine, brown, unconsolidated, lots of free water.
		(Air rotary drilled)

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TABLE OF GOLF COURSE MONITOR WELL
FIELD SAMPLE DESCRIPTION

GC-1	0-50	Clay, silty, reddish brown grading to brown, plastic.
	50-62 TD*	Sand, brown, fine to very fine, unconsolidated, water.
		(Air rotary drilled)

NOTE: * Denotes total depth air rotary drilled.

TABLE OF CHEMICAL DISPOSAL PIT NO. 3 FIELD SAMPLE DESCRIPTIONS

Location Designation	Depth (Feet)	Sample Description
CP3-1	0-1.0	Soil, silty clay, very dark brown; note "0" is in disposal trench ∿1.5 feet below ground level.
	1.0∿1.4 TD*	Clay, silt, black, damp, solvent odor.
		(Hand augered)
CP3-2	0-1.5	Soil, silty clay, very dark brown.
	1.5-2.0 TD	Clay, silty, black, solvent odor.
		(Hand augered)
CP3-3	0-1.5	Soil, silty sand, dark brown, moist, unconsolidated.
	1.5-2.0 TD	Silty sand, brown, moist, unconsolidated.
		(Hand augered)
CP3-4	0-0.5	Clay, silty, dark brown,
	0.5-1.0 TD	Clay, brown, almost black, visibly moist, solvent odor; note "0" *is at bottom* of pit which is ∿1.5 feet below ground level.
		(Hand augered)
CP3-5	0-2.5	Soil, silty clay, very dark brown, plastic.
	2.5-3.5 TD	Clay, brown, plastic.
		(Hand augered)
CP3-6	0-3.0 TD	Soil, silty sand. See auger hole A-1.
		(Hand augered)
CP3-6 (A-1)[1]	3.0-7.5	Clay, sandy, tannish brown.
	6+	-- (Split spoon sample)
	7.5-9	Gravel and sand (?)
	9-10	Clay, sandy, tannish brown.
	10∿12 TD	-- (Split spoon sample).
		(Hollow stem augered)

(Continued)

NOTE: * *Denotes total depth, hand or hollow stem augered.*
[1] Parentheses indicate number of colocated hollow- or solid-stem auger hole. The "CP3" prefix is not shown.

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(CHEMICAL DISPOSAL PIT NO. 3 FIELD SAMPLE DESCRIPTIONS - continued)

Location Designation	Depth (Feet)	Sample Description
CP3-7	0-1.0	Soil, clayey, very dark brown.
	1.0-2.0 TD	Clay, silt, brown.
		(Hand augered)
CP3-8	0-1.0	Soil, clayey sand, brown.
	1.0-1.5 TD	Clay, silty, very dark brown.
		(Hand augered)
CP3-9	0-1.5	Clay, silt and gravel, dark brown; note "0" is ∿1.5 feet below ground level.
	1.5-2.5	Clay, sandy, very wet metallic sheen, strong solvent odor.
	2.5-3.0 TD	Sand, gravel, pebbles.
		(Hand augered)
CP3-10	0-1.0 TD	Clay, silty, dark brown, unconsolidated.
		(Hand augered)
CP3-11	0-1.5 TD	Clay, dark brown, unconsolidated with gravel and pebbles.
		(Hand augered)
CP3-12	0-0.5	Soil, silty clay, dark brown.
	0.5-1.0 TD	Clay, brown.
		(Hand augered)
CP3-13	0-1.5	Sand, gravel, pebbles, unconsolidated, fill material?
	1.5-2.0 TD	Clay, silty, brown.
		(Hand augered)
CP3-14	0-1.5 TD	Soil, silty clay.
		(Hand augered)

(Continued)

(CHEMICAL DISPOSAL PIT NO. 3 FIELD SAMPLE DESCRIPTIONS - continued)

Location Designation	Depth (Feet)	Sample Description
CP3-15 (A-2)	0-5.0	Clay, dark brown, semi-plastic.
	5.0-6.5	Clay, brown, dense and dry (Split spoon sample).
	6.5-15.0	Clay, brown, dense and dry.
	15.0-16.5 TD	Clay, brown, dense and dry, last 0.1 feet seemed softer and moist.
		(Hollow stem augered)
CP3L-1		See CP3-13 sample description.
CP3L-2		See CP3-6 sample description, was also hollow stem auger hole A-1.
CP3L-3		See piezometer P-5 sample description, L-3 is adjacent to piezometer P-5.

(Continued)

(CHEMICAL DISPOSAL PIT NO. 3 FIELD SAMPLE DESCRIPTIONS - continued)

Location Designation	Depth (Feet)	Sample Description
P-1 (A-3)	0-1.5	Topsoil and gravel, dark brown.
	1.5-7.0	Clay, brown, plastic, moist.
	7.0-7.5	Sand, brown, fine to very fine, unconsolidated.
	7.5-20.0	Gravel, minor sand, brown; gravel as large as 1-2 inches across.
	20.0-20.5	Sand, tan, fine to very fine, unconsolidated.
	20.5-22.0	Clay, reddish brown, wet (Split spoon sampled).
	22.0-24.5	Clay.
	24.5-26.0 TD	Clay, greyish brown.
		(Hollow stem augered)

(Continued)

(CHEMICAL DISPOSAL PIT NO. 3 FIELD SAMPLE DESCRIPTIONS - continued)

Location Designation	Depth (Feet)	Sample Description
P-2 (A-4)	0-2.0	Topsoil, sand, gravel and clay, dark brown.
	2.0-5.5	Sand, tan, fine to very fine, unconsolidated.
	5.5-17.0	Gravel, minor sands, tan, unconsolidated.
	17.0-19.0	Clay.
	19.0-20.0	Clay, brown plastic (Split spoon sampled).
	20.0-20.5	Clay, greyish brown, plastic (Split spoon sampled).
	20.5-35.0 TD	Clay, appears to turn darker grey and distinctly moist after 25 ft.; ∿27 ft. driller noted clay drilled sandier.
		(Hollow stem augered)

(Continued)

(CHEMICAL DISPOSAL PIT NO. 3 FIELD SAMPLE DESCRIPTIONS - continued)

Location Designation	Depth (Feet)	Sample Description
P-3 (A-5)	0-8.0	Clay, brown, silty, dry appearing.
	8.0-10.0	Clay, brown, plastic.
	10.0-10.5	Clay, brown (Split spoon sampled).
	10.5-10.9	Clay, sand and gravel (Split spoon sampled).
	10.9-14.0	Clay, brown
	14.0-18.0	Sand, light brown, wet and creamy texture.
	18.0-25.0	Clay, brown
	25.0-26.4	Clay, brown (Split spoon sampled).
	26.4-27.0	Sand, gravel, coarse brown wet (Split spoon sampled).
	27.0-27.3	Clay, brownish grey silty (Split spoon sampled).
	27.3-27.6	Sand, gravel, tan, coarse (Split spoon sampled).
	27.6-27.9	Clay, brown (Split spoon sampled).
	28.0-28.6	Sand, coarse tan (Split spoon sampled).
	28.6-29.0 TD	Clay, brown.
		(Hollow stem augered)
P-4		See P-3 log; P-4 adjacent to P-3.
		(Hollow stem augered)

(Continued)

(CHEMICAL DISPOSAL PIT NO. 3 FIELD SAMPLE DESCRIPTIONS - continued)

Location Designation	Depth (Feet)	Sample Description
P-5	0.0-6.0	Sand, silty, tan, unconsolidated.
(A-6)	6.0-17.5	Gravel and sand, tan, gravel ∿½-1 inch across.
	∿11	Samples look moist.
	17.5-17.6	Sand, tan, moist (Split spoon sample).
	17.6-19.2	Clay, brown (Split spoon sample).
	19.2-20.5	Clay.
	20.5-22.1	Clay, greyish brown (Split spoon sample).
	22.1-25.0	Clay, greyish brown.
	∿25.0	Clay, dark grey (auger bit).
	25.0-40.0	Clay.
	40.0-41.8	Clay, brownish grey (Split spoon sample).
	41.8-45.0	Clay.
	45.0-46.0	Clay, dark grey, wet (Split spoon sample).
	46.0-50.0	Clay.
	50.0-51.3 TD	Clay, dark grey, wet, appears to have silt stringer (Split spoon sample).
		(Hollow stem augered)

(Continued)

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(CHEMICAL DISPOSAL PIT NO. 3 FIELD SAMPLE DESCRIPTIONS - continued)

Location Designation	Depth (Feet)	Sample Description
P-6	0-9	Clay, brown, plastic.
(A-7)	5.0-5.7	Clay, brown (Split spoon sample).
	9-10	Clay, sandy, very soft augering, moist.
	10-17	Clay, brown, dry.
	17-19	Sand, brown, fine to very fine, unconsolidated.
	19-20.4	Sand, tan, very fine, moist, unconsolidated (Split spoon sample).
	20.5-21.5	Sand, tan, fine to very fine, strong solvent odor, moist, unconsolidated (Split spoon sample).
	22-23.5	Sand, tan, fine to very fine, very strong solvent odor, some free water, unconsolidated (Split spoon sample).
	23.5-25.2	Sand, tan, fine to very fine, free water, strong solvent odor, unconsolidated (Split spoon sample).
	25.2∿26.5	Sand.
	∿26.5	Gravel.
	26.5-40 TD	Sand, gravel, tan, medium to fine, gravel ∿½ inch across and well rounded, formation easily collapses and heaves, unconsolidated.
		(Solid and hollow stem augered)

(Continued)

(CHEMICAL DISPOSAL PIT NO. 3 FIELD SAMPLE DESCRIPTIONS - continued)

Location Designation	Depth (Feet)	Sample Description
P-7 (A-8)	0-4.5	Sand, gravel, brown, gravel ∿¼ inch across, unconsolidated.
	4.5-5.8	Clay, brown, hard and dry (Split spoon sample), horizontal parting (?) ∿0.1 ft.
	5.8-14.0	Clay, brown.
	14.0-15.8	Clay, brown, dry, breaks easily (Split spoon sample).
	15.8-29.0	Clay, brown.
	29.0-30.0	Clay, brown, very moist and plastic, solvent odor (Shelby tube sample.
	30.0-31.5	Clay, brownish grey, hard, solvent odor (Shelby tube sample).
	31.5-33.4 TD	Clay, light brownish grey, contained horizontal black silt (?) layers (Shelby tube sample).
		(Solid and hollow stem augered)

Rig was moved south ∿5 feet to obtain a soil sample from a depth of about 3 feet (vicinity of clay contact). Sample description follows:

	2.0-2.3	Sand, gravel, dark grey moist, unconsolidated (Split spoon sample).
	2.3-2.9	Sand, gravel, tan, unconsolidated (Split spoon sample).
	2.9-3.0 TD	Clay, reddish brown, hard, dry (Split spoon sample).

(Continued)

(CHEMICAL DISPOSAL PIT NO. 3 FIELD SAMPLE DESCRIPTIONS - continued)

Location Designation	Depth (Feet)	Sample Description
P-8 (A-9)	0-2.5	Soil, clay, very dark grey, unconsolidated.
	2.5-4.0	Clay, reddish brown.
	4.0-5.0	Sand, gravel, gravel ∿¼ to 1 inch, moist, unconsolidated.
	5.0-6.0	Sand, gravel, tan, medium to fine, gravel ∿¼ inch to 1 inch across, rounded to sub-rounded (Split spoon sample).
	∿7.5	Sand, gravel.
	∿11.5	-- no cutting returns.
	14.0	Sand, silt, tan, plastic, difficult augering, unconsolidated (Bit sample).
	∿25	Sand, tan, fine to very fine, water, unconsolidated.
	∿29	Sand, gravel, tan, medium, unconsolidated.
	29.5	Clay, brown, moist, plastic.
	29.5-38 est	Clay, brown, plastic.
	∿38	Clay, grey, estimated depth to contact between a brown and grey clay.
	45-45.8	Clay, grey, moist plastic (Split spoon sample).
	45.8-46 TD	Clay, grey, hard (Split spoon sample).
		(Solid stem augered)

(Continued)

CHEMICAL DISPOSAL PIT NO. 3 FIELD SAMPLE DESCRIPTIONS - continued)

Location Designation	Depth (Feet)	Sample Description
P-9 (A-9)		See P-8 log to 28 feet; P-9 about 10 feet adjacent to P-8.
	∿28	Clay.
	28.5-30.0 TD	Clay, grey with black streaks, semi-plastic, sample parts along preferred horizontal planes, split spoon was pushed in rather than driven as all other split spoon samples.
		(Hollow stem augered)

(Continued)

(CHEMICAL DISPOSAL PIT NO. 3 FIELD SAMPLE DESCRIPTIONS - continued)

Location Designation	Depth (Feet)	Sample Description
P-10	0∿2	Clay, sandy, almost black.
(A-10)	∿2-5.0	Sand, gravel, brown, unconsolidated.
	5.0-6.4	Clay, sandy, reddish brown, dry.
	6.4-10.0	Sand, brown, unconsolidated.
	10-10.5	Sand, gravel, tan, slight solvent odor, unconsolidated, (Split spoon sample).
	10∿14	Sand, gravel, gravel; ¼ to 2-inches across, rounded, unconsolidated.
	∿14	Clay.
	15.0-16.3	Clay, reddish brown, dry, breaks easily, very slight solvent odor (?).
	16.3∿21	Clay.
	∿21-25.0	Sand.
	25.0-26.2	Sand, gravel, tan, wet, no odor, unconsolidated.
	26.2-28.0	Sand.
	28.0-29.0	Sand, gravel, tan, wet, unconsolidated (Split spoon sample).
	29.0-29.6 TD	Clay, reddish brown.
		(Hollow stem augered)

RADIAN CORPORATION

Well Completion Log: Sheet 1/2

Sheet 1 of 2

Boring or Well No. M-1
Project Hill AFB IRP Phase II
Location Chemical Disposal Nos. 1&2 Area
Log Recorded By R. Belan
Corresponding Tape # --

Construction started 11/9/82 completed 11/10/82

Total depth drilled (ft) 33
Hole diameter (ft) ~6 1/2-inch
Drilling method Air rotary with casing drive
Problems encountered during drilling None

Water source for drilling and completion procedures Hill AFB potable system

Number and type of samples collected Air rotary composite (2) for visual examination and potential chemical analysis.
Sample interval (ft-ft) 14-18; 27-32 environmental
Storage method(s) Ice chest and Bioenvironmental Engineer refrigerator.

Casing type Steel Diameter (ft) 0.56 (6 3/4")
Depth of casing (ft) 28.3 (6 3/4-inch)
Screen type Stainless steel 1/ Diameter (ft) 0.5 (5 5/8-inch)
Slot size 0.010-inch Screen interval (ft-ft) 26.0-31.0
Type(s) of glue used to join casing none; welded

Type of gravel pack used None ; natural pack
Amount of gravel pack used --
Grain size distribution of gravel pack --
Lithology of gravel pack --
Source (company and quarry/pit) --

Interval of gravel pack (ft-ft) --
Interval of bentonite seal (ft-ft) --
Interval of grouting (ft-ft) 0-5

Description of security measures Plastic compression plug with locking wing nut.

NOTE: 1/ Johnson telescoping screen (5.5') with k-packer.

Padlock ID No. P592 Location of key(s) Hill AFB Bioengineer (6) Radian (3), CDI (1), USTL (1)

RADIAN CORPORATION

Sheet 2 of 2

Well Completion Log: Sheet 2/2

Boring or Well No. M- 1

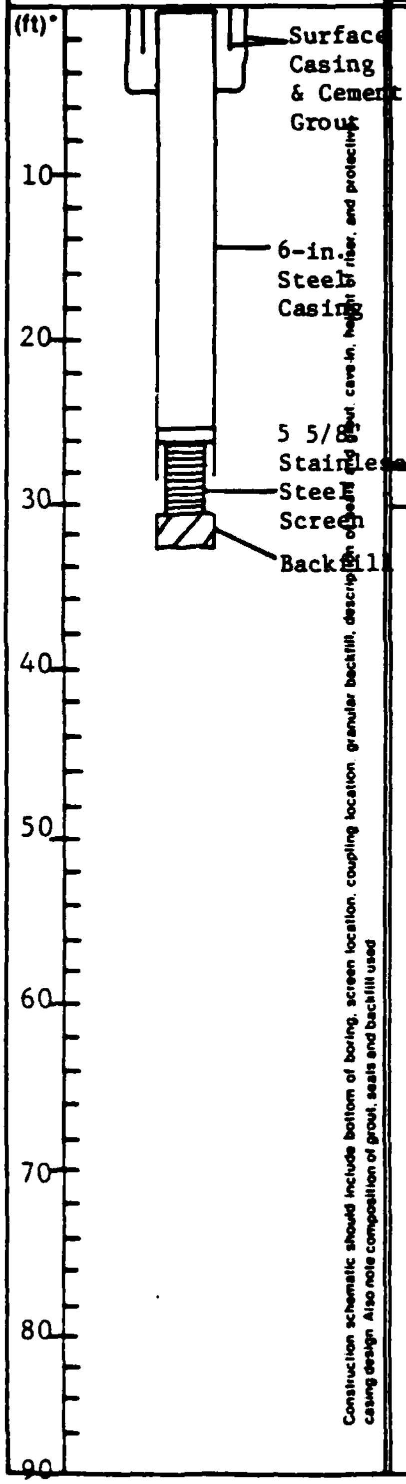
Location Chemical Disposal Nos. 1&2 Area

Project Hill AFB IRP Phase II

Log Recorded By R. Belan

Corresponding Tape # --

Construction Schematic



*Construction schematic should include bottom of boring, screen location, coupling location, granular backfill, description of grout, cave-in, height of riser, and protective casing design. Also note composition of grout, seals and backfill used

Static level of water before 23.2 (ft) and after 22.5 (ft) development

Development started 12/10/82

Development ended 1/14/83

Quantity of water discharged during development >4.3 (ft^3)

Type, size/capacity of pump or bailer used for development 3" x 2.7' PVC ball valve bailer; capacity: 0.08 ft^3

Depth of open hole inside well

Before development 31.0 (ft)

After development 30.1 (ft)

Development Summary

The ground water discharged during primary development had an average field temperature of 11.8°C ranging from 8.0 °C to 14.0 °C. Conductivity measurements average 590 μmhos/cm ranging from 530 to 700 μmhos/cm. Measured pH values averaged 7.1 and ranged from 6.7 to 7.4. Initial discharges were muddy and silty tending to clear up later in development. A slight odor to ground water discharged at end of development was noticed.

RADIAN CORPORATION

Well Completion Log: Sheet 1/2

Sheet 1 of 2

Boring or Well No. M-2

Location Chemical Disposal Pit Nos. 1 & 2 Area

Project Hill AFB IRP Phase II

Log Recorded By R. Belar

Corresponding Tape # --

Construction started 11/11/82 completed 11/11/82

Total depth drilled (ft) 33

Hole diameter (ft) ~6 1/2-inch

Drilling method Air rotary with casing drive

Problems encountered during drilling None

Water source for drilling and completion procedures Hill AFB potable system

Number and type of samples collected Air rotary composite (2) for visual examination and potential chemical analysis.

Sample interval (ft-ft) 10-16; 25-30

Storage method(s) Ice chest and Bioenvironmental Engineer refrigerator.

Casing type Steel Diameter (ft) 0.56 (6 3/4")

Depth of casing (ft) 28.1 (6 3/4-inch)

Screen type Stainless steel[1/] Diameter (ft) 0.5 (5 5/8-inch)

Slot size 0.010-inch Screen interval (ft-ft) 27.3-32.3

Type(s) of glue used to join casing none; welded

Type of gravel pack used None

Amount of gravel pack used --

Grain size distribution of gravel pack --

Lithology of gravel pack --

Source (company and quarry/pit) --

Interval of gravel pack (ft-ft) --

Interval of bentonite seal (ft-ft) --

Interval of grouting (ft-ft) 0-5

Description of security measures Plastic compression plug with locking wing nut.

NOTE: [1/] Johnson telescoping screen (5.5') with k-packer.

Padlock ID No. P592 Location of key(s) Hill AFB Bioengineer (6) Radian (3), CDI (1), USTL (1)

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Well Completion Log: Sheet 2/2

Sheet 2 of 2

Boring or Well No. M-2

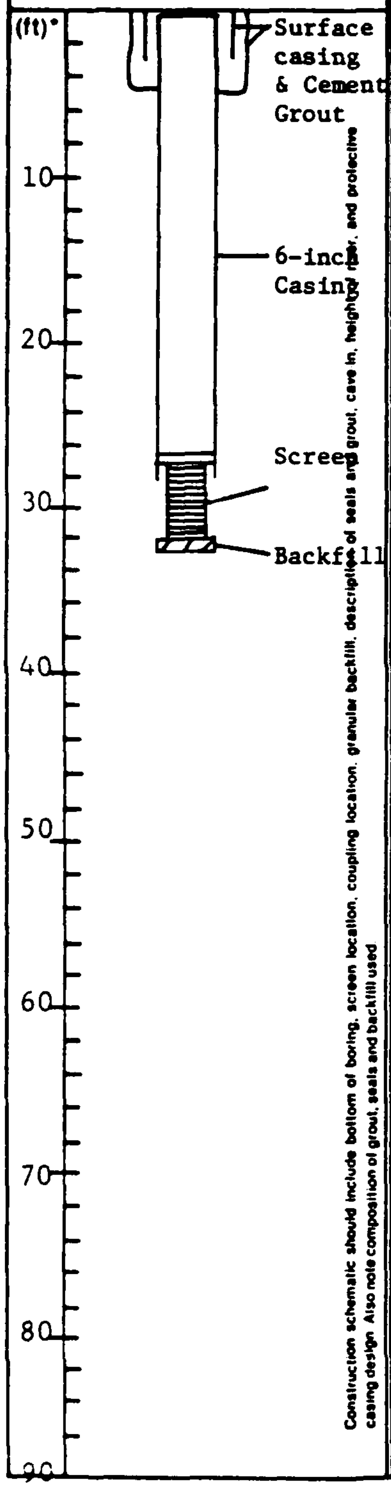
Location Chemical Disposal Pit Nos. 1&2 Area

Project Hill AFB IRP Phase II

Log Recorded By R. Belan

Corresponding Tape # --

Construction Schematic



Static level of water before 26.6 (ft) and after 26.7 (ft) development

Development started 12/14/82

Development ended 1/14/83

Quantity of water discharged during development >1.2 (ft^3)

Type, size/capacity of pump or bailer used for development 3" x 2.7' PVC ball valve bailer; capacity: 0.08 ft^3

Depth of open hole inside well

Before development 32.3 (ft)

After development 32.1 (ft)

Development Summary

The ground water discharged during primary development had field temperatures of 12.0°C. Conductivity measurements averaged 875 μmhos/cm ranging from 800 to 950 μmhos/cm. Measured pH values averaged 7.1 and ranged from 6.7 to 7.4. Bailed ground water had a strong odor. Early bailed water was murky gray; tended to clear up towards the end of development.

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RADIAN CORPORATION

Well Completion Log: Sheet 1/2

Sheet 1 of 2

Boring or Well No. M- 3

Project Hill AFB IRP Phase II

Location Chemical Disposal Pit Nos. 1&2 Area

Log Recorded By R. Belar.

Corresponding Tape # --

Construction started 12/2/82 completed 12/29/82

Total depth drilled (ft) 92

Hole diameter (ft) ~7 inch

Drilling method Air rotary with casing drive

Problems encountered during drilling Difficult to detect a bottom of clay. Drill rig got stuck due to bad weather.

Water source for drilling and completion procedures Hill AFB potable system, biodegradable drilling foam (Kim-Ko, Inc.)

Number and type of samples collected Air rotary composite (2) for visual examination and potential chemical analysis.

Sample interval (ft-ft) 8-10; 24-30

Storage method(s) Ice chest and Bioenvironmental Engineer refrigerator.

Casing type 8" Steel and 4" PVC

Diameter (ft) 0.56 (6 3/4"); 0.72 (8 5/8")

Depth of casing (ft) ~58 (4-inch) 39 (8 5/8-inch) & drive shoe

Screen type Slotted

Diameter (ft) 0.3 (4-inch)

Slot size 1/8" x 5"; 2/foot

Screen interval (ft-ft) 43-58

Type(s) of glue used to join casing none: welded

Type of gravel pack used None

Amount of gravel pack used --

Grain size distribution of gravel pack --

Lithology of gravel pack --

Source (company and quarry/pit) --

Interval of gravel pack (ft-ft) --

Interval of bentonite seal (ft-ft) --

Interval of grouting (ft-ft) 0-5 and capped gravel in annulus.

Description of security measures Plastic compression plug with locking wing nut.

Padlock ID No. P592

Location of key(s) Hill AFB Bioengineer (6) Radian (3), CDI (1), USTL (1)

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Sheet 2 of 2

Well Completion Log: Sheet 2/2

Boring or Well No. M- 3

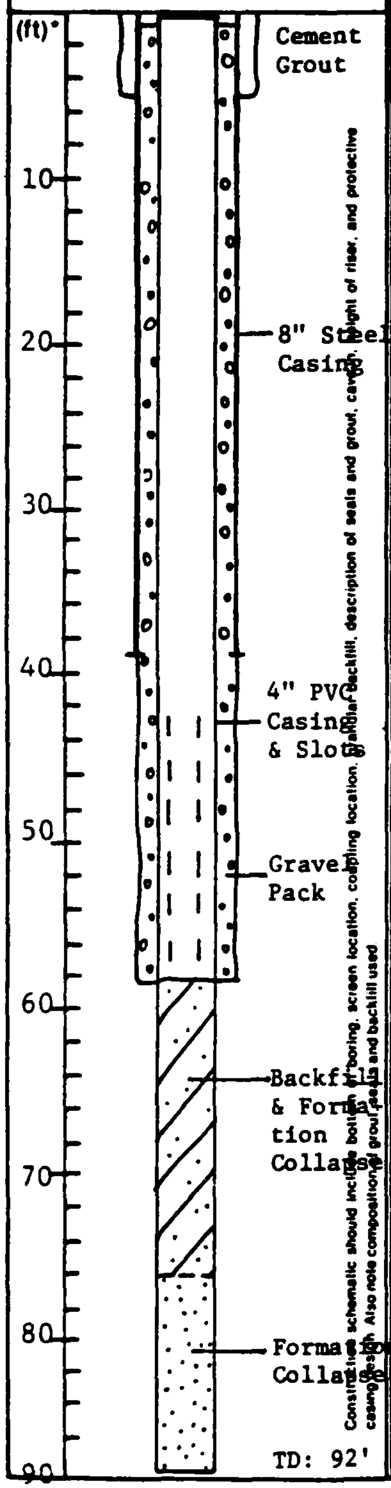
Project Hill AFB IRP Phase II

Location Chemical Disposal Pit Nos. 1&2 Area

Log Recorded By R. Belan

Corresponding Tape # --

Construction Schematic



Static level of water before 32.8 (ft) and after 33.0 (ft) development

Development started 11/12/82

Development ended 1/12/83

Quantity of water discharged during development >6.0 (ft^3)

Type, size/capacity of pump or bailer used for development 3" x 2.7' PVC ball valve bailer; capacity: 0.08 ft^3

Depth of open hole inside well

Before development ∿58 (ft)

After development 55.7 (ft)

Development Summary

The ground water discharged during primary development had an average field temperature of 10.6°C ranging from 10.0 C° to 11.0°C. Conductivity measurements averaged 390 µmhos/cm ranging from 320 to 460 µmhos/cm. Measured pH values averaged 7.2 and ranged from 7.1 to 7.4. Initial water developed was muddy with a very slight odor which tended to clear up by the end of development. Water would muddy up as ground-water level drew down towards bottom.

RADIAN CORPORATION

Well Completion Log: Sheet 1/2

Sheet 1 of 2

Boring or Well No. M- 4
Location Chemical Disposal Pits Nos. 1&2 Area

Project Hill AFB IRP Phase II
Log Recorded By R. Belan
Corresponding Tape # --

Construction started 11/11/82 completed 11/12/82

Total depth drilled (ft) 27 1/2
Hole diameter (ft) ~6 1/2-inch
Drilling method Air rotary with casing drive
Problems encountered during drilling Very little water encountered initially; set screen into clay (25') to act as a sump.
Water source for drilling and completion procedures Hill AFB potable system

Number and type of samples collected Air rotary composite (2) for visual examination and potential chemical analysis.
Sample interval (ft-ft) 18-22; 24-26
Storage method(s) Ice chest and Bioenvironmental Engineer refrigerator.

Casing type Steel Diameter (ft) 0.56 (6 3/4")
Depth of casing (ft) 22.2 (6 3/4-inch)
Screen type Stainless steel 1/ Diameter (ft) 0.5 (5 5/8-inch)
Slot size 0.010-inch Screen interval (ft-ft) 20.4-25.4
Type(s) of glue used to join casing none; welded

Type of gravel pack used None
Amount of gravel pack used --
Grain size distribution of gravel pack --
Lithology of gravel pack --
Source (company and quarry/pit) --

Interval of gravel pack (ft-ft) --
Interval of bentonite seal (ft-ft) --
Interval of grouting (ft-ft) 0-5

Description of security measures Plastic compression plug with locking wing nut.

NOTE: 1/ Johnson telescoping screen (5.5') with k-packer.

Padlock ID No. P592 Location of key(s) Hill AFB Bioengineer (6) Radian (3), CDI (1), USTL (1)

RADIAN CORPORATION

Sheet 2 of 2

Well Completion Log: Sheet 2/2

Boring or Well No. M-4

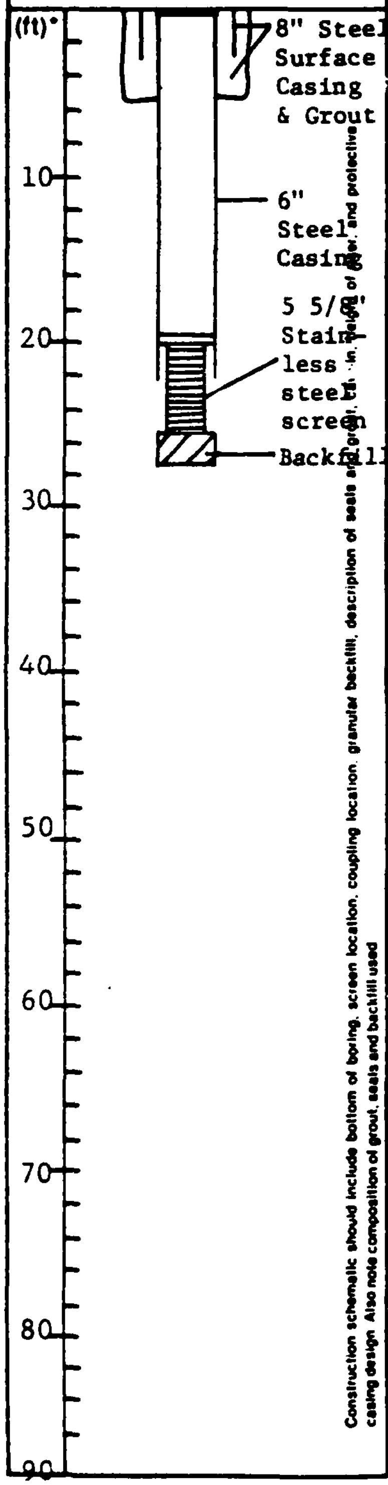
Location Chemical Disposal Pits Nos. 1&2 Area

Project Hill AFB IRP Phase II

Log Recorded By R. Belan

Corresponding Tape # --

Construction Schematic



*Construction schematic should include bottom of boring, screen location, coupling location, granular backfill, description of seals and grout, height of riser, and protective casing design. Also note composition of grout, seals and backfill used

Static level of water before 23.8 (ft) and after 23.8 (ft) development

Development started 12/9/82

Development ended 1/14/83

Quantity of water discharged during development >0.3 (ft^3)

Type, size/capacity of pump or bailer used for development 3" x 2.7' PVC ball valve bailer; capacity: 0.08 ft^3

Depth of open hole inside well

Before development 25.4 (ft)

After development 25.2 (ft)

Development Summary

The ground water discharged during primary development had an average field temperature of 10.6°C ranging from 10.0°C to 11.0°C. Conductivity measurements averaged 819 µmhos/cm ranging from 750 to 900 µmhos/cm. Measured pH values averaged 7.1 and ranged from 7.0 to 7.1 Initial ground water bailed was murky and light brown. There was very little ground water in well to develop.

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Sheet 1 of 2

Well Completion Log: Sheet 1/2

Boring or Well No. M- 6
Location Landfill No. 3 area

Project Hill AFB IRP Phase II
Log Recorded By R. Belan
Corresponding Tape # --

Construction started 11/17/82 completed 11/22/82

Total depth drilled (ft) 77
Hole diameter (ft) ~6 1/2-inch
Drilling method Air rotary with casing drive
Problems encountered during drilling Difficult to detect a bottom of clay.

Water source for drilling and completion procedures Hill AFB potable system

Number and type of samples collected None

Sample interval (ft-ft) --
Storage method(s) --

Casing type Steel Diameter (ft) 0.56 (6 3/4"); 0.72 (8 5/8")
Depth of casing (ft) 36.2 (6 3/4-inch) 28 (8 5/8-inch)
Screen type Stainless steel[1] Diameter (ft) 0.5 (5 5/8-inch)
Slot size 0.010-inch Screen interval (ft-ft) 35.7-40.7
Type(s) of glue used to join casing none; welded

Type of gravel pack used None
Amount of gravel pack used --
Grain size distribution of gravel pack --
Lithology of gravel pack --
Source (company and quarry/pit) --

Interval of gravel pack (ft-ft) --
Interval of bentonite seal (ft-ft) --
Interval of grouting (ft-ft) 0- 5; 0~28 (annulus)

Description of security measures Plastic compression plug with locking wing nut.

NOTE: [1] Johnson telescoping screen (5.5') with k-packer.

Padlock ID No. P592 Location of key(s) Hill AFB Bioengineer (6)
Radian (3), CDI (1), USTL (1)

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Sheet 2 of 2

Well Completion Log: Sheet 2/2

Boring or Well No. M-6

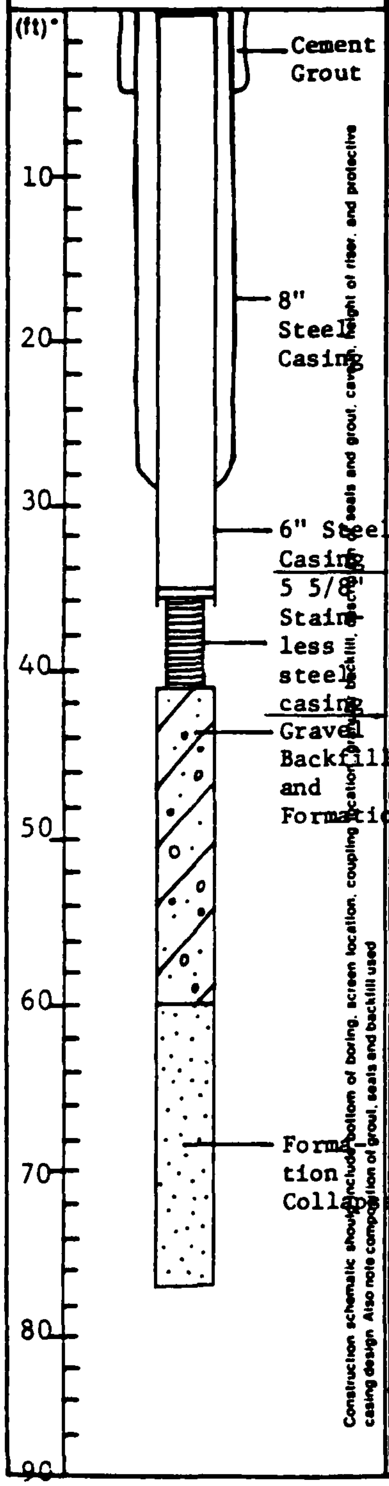
Location Landfill No. 3 area

Project Hill AFB IRP Phase II

Log Recorded By R. Belan

Corresponding Tape # --

Construction Schematic



Static level of water before 17.4 (ft) and after 17.6 (ft) development

Development started 12/16/82

Development ended 1/12/83

Quantity of water discharged during development >13.8 (ft³)

Type, size/capacity of pump or bailer used for development 3" x 2.7' PVC ball valve bailer; capacity: 0.08 ft³

Depth of open hole inside well

Before development (ft)

After development 40.7 (ft)

Development Summary

The ground water discharged during primary development had an average field temperature of 10.8°C ranging from 10.0°C to 12.0°C. Conductivity measurements averaged 428 μmhos/cm ranging from 360 to 480 μmhos/cm. Measured pH values averaged 7.3 and ranged from 7.0 to 7.8. Initial bailed ground water was gray and murky clearing by the end of development. Nothing unusual noted during development.

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Well Completion Log: Sheet 1/2

Sheet 1 of 2

Boring or Well No. M- 7
Location Landfill No. 3 area
Project Hill AFB IRP Phase II
Log Recorded By R. Belan
Corresponding Tape # --

Construction started 11/17/82 completed 11/22/82

Total depth drilled (ft) 25
Hole diameter (ft) ~6 1/2-inch
Drilling method Air rotary with casing drive
Problems encountered during drilling Screen got stuck in casing requiring a pullout and a planned reset with 4" PVC. Screen damaged but useable.
Water source for drilling and completion procedures Hill AFB potable system

Number and type of samples collected Air rotary composite (2) for visual examination and potential chemical analysis.
Sample interval (ft-ft) 13-16; 17-22
Storage method(s) Ice chest and Bioenvironmental Engineer refrigerator.

Casing type 6" Steel & 4" PVC Diameter (ft) 0.56 (6 3/4"); 0.3 (4-inch)
Depth of casing (ft) 10.8 (6 3/4-inch) 18.8 (4-inch)
Screen type Slotted Diameter (ft) 0.3 (4-inch)
Slot size 1/8" x 5"; 2/foot Screen interval (ft-ft) 13.5-18.8
Type(s) of glue used to join casing none; welded

Type of gravel pack used ~1/4-3/8 gravel
Amount of gravel pack used ~8 gallons
Grain size distribution of gravel pack --
Lithology of gravel pack Mixed
Source (company and quarry/pit) Construction Drilling International.

Interval of gravel pack (ft-ft) ~12.5-19.5
Interval of bentonite seal (ft-ft) None
Interval of grouting (ft-ft) 0-5

Description of security measures Plastic compression plug with locking wing nut.

Padlock ID No. P592 Location of key(s) Hill AFB Bioengineer (6) Radian (3), CDI (1), USTL (1)

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CORPORATION

Well Completion Log: Sheet 2/2

Boring or Well No. M- 7

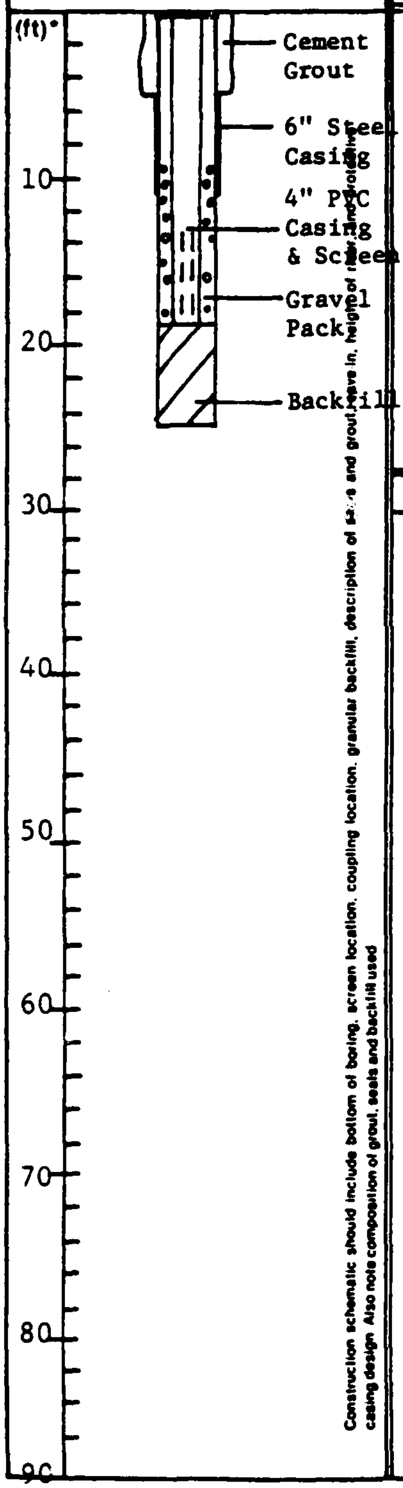
Project Hill AFB IRP Phase II

Location Landfill No. 3 Area

Log Recorded By R. Belan

Corresponding Tape # --

Construction Schematic



Static level of water before 17.1 (ft) and after 16.8 (ft) development

Development started 12/14/82

Development ended 1/14/83

Quantity of water discharged during development 0.2 (ft^3)

Type, size/capacity of pump or bailer used for development 3" x 2.7' PVC ball valve bailer; capacity: 0.08 ft^3

Depth of open hole inside well

Before development 18.8 (ft)

After development 18.8 (ft)

Development Summary

The ground water discharged during primary development had an average field temperature of 9.3°C ranging from 8.5°C to 10.0°C. Conductivity measurements averaged 550 μmhos/cm ranging from 500 to 600 μmhos/cm. Measured pH values averaged 7.3 and ranged from 7.1 to 7.5. Very little ground water to develop. Nothing else noted unusual during development.

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RADIAN CORPORATION

Well Completion Log: Sheet 1/2

Sheet 1 of 2

Boring or Well No. M-9

Project Hill AFB IRP Phase II

Location Landfill No. 3 Area

Log Recorded By R. Belar

Corresponding Tape # --

Construction started 11/12/82 completed 11/17/82

Total depth drilled (ft) 15

Hole diameter (ft) ~6 1/2-inch

Drilling method Air rotary with casing drive

Problems encountered during drilling --

Water source for drilling and completion procedures Hill AFB potable system

Number and type of samples collected Air rotary composite (2) for visual examination and potential chemical analysis.

Sample interval (ft-ft) 0.7; 7-10

Storage method(s) Ice chest and Bioenvironmental Engineer refrigerator.

Casing type 6" Steel & ABS (4-inch) Diameter (ft) 0.56 (6 3/4"); 0.3 (4-inch)

Depth of casing (ft)* 11.2 (6 3/4-inch); 15 (4-inch)

Screen type ABS plastic Diameter (ft) 0.3 (4-inch)

Slot size 1/4" holes Screen interval (ft-ft) 5-15

Type(s) of glue used to join casing none

Type of gravel pack used ~1/4-3/8 gravel

Amount of gravel pack used ~18 gallons

Grain size distribution of gravel pack --

Lithology of gravel pack Mixed

Source (company and quarry/pit) Construction Drilling International

Interval of gravel pack (ft-ft) 0-15

Interval of bentonite seal (ft-ft) None

Interval of grouting (ft-ft) 0-3

Description of security measures Plastic compression plug with locking wing nut.

NOTE: PVC plastic casing had been requested of driller instead of ABS plastic.

Padlock ID No. P592 Location of key(s) Hill AFB Bioengineer (6) Radian (3), CDI (1), USTL (1)

RADIAN CORPORATION

Well Completion Log: Sheet 2/2

Sheet 2 of 2

Boring or Well No. M- 9

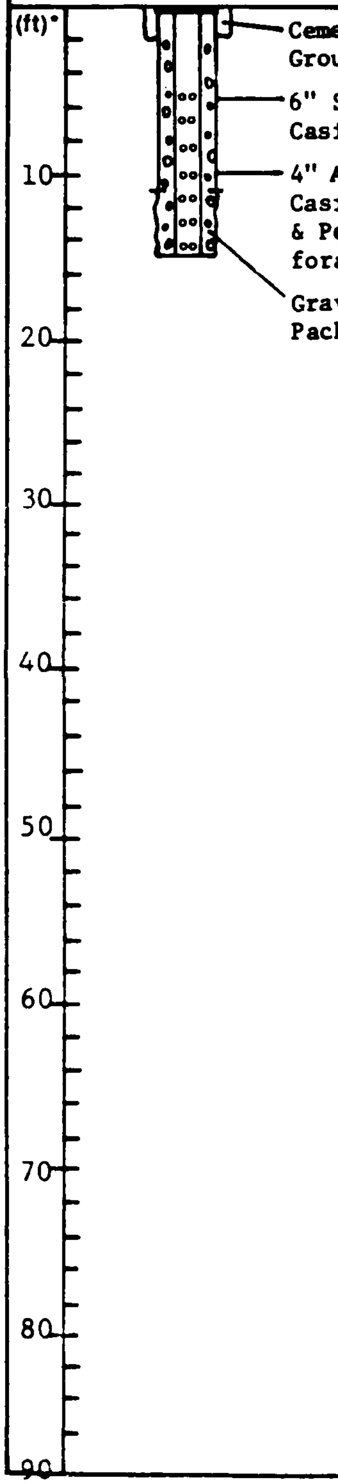
Project Hill AFB IRP Phase II

Location Landfill No. 3 Area

Log Recorded By R. Belan

Corresponding Tape # --

Construction Schematic



Construction schematic should include bottom of boring, screen location, coupling location, granular backfill, description of seals and grout, cave-in, depth of ... casing design. Also note composition of grout, seals and backfill used

Static level of water before 1.5 (ft) and after 1.4 (ft) development

Development started 12/9/82

Development ended 1/14/83

Quantity of water discharged during development ~2.0 (ft^3)

Type, size/capacity of pump or bailer used for development 3" x 2.7' PVC ball valve bailer; capacity: 0.08 ft^3

Depth of open hole inside well

Before development 14.1 (ft)

After development 10.5 (ft)

Development Summary

The ground water discharged during primary development had an average field temperature of 5.3°C ranging from 3.0°C to 6.0°C. Conductivity measurements average 2,675 μmhos/cm ranging from 2,550 to 2,850 μmhos/cm. Measured pH values averaged 6.3 and ranged from 5.6 to 7.5. Initial ground water discharged was murky brown slightly clearing by the end of development, although not entirely. Silt and clay size particles enter the wells as water seeps into evacuated well bore.

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RADIAN CORPORATION

Well Completion Log: Sheet 1/2

Sheet 1 of 2

Boring or Well No. M- 10

Location Landfill No. 3 Area

Project Hill AFB IRP Phase II

Log Recorded By R. Belar

Corresponding Tape # --

Construction started 11/23/82 completed 11/30/82

Total depth drilled (ft) 34

Hole diameter (ft) ~6 1/2-inch

Drilling method Air rotary with casing drive

Problems encountered during drilling None

Water source for drilling and completion procedures Hill AFB potable system, used small amount of water to clean out inside of casing upon withdrawal.

Number and type of samples collected Air rotary composite (2) for visual examination and potential chemical analysis.

Sample interval (ft-ft) 2-5; ~13

Storage method(s) Ice chest and Bioenvironmental Engineer refrigerator.

Casing type Steel Diameter (ft) 0.56 (6 3/4"); 0.72 (8 5/8")

Depth of casing (ft) 30.0(6 3/4-inch) 18 (8 5/8-inch)

Screen type Diameter (ft) 0.5 (5 5/8-inch)

Slot size 0.010-inch Screen interval (ft-ft) 28.8-34.0

Type(s) of glue used to join casing none; welded

Type of gravel pack used None

Amount of gravel pack used --

Grain size distribution of gravel pack --

Lithology of gravel pack --

Source (company and quarry/pit) --

Interval of gravel pack (ft-ft) --

Interval of bentonite seal (ft-ft) --

Interval of grouting (ft-ft) 0-5; 0 ~ 18 (annulus)

Description of security measures Plastic compression plug with locking wing nut.

NOTE: 1/ Johnson telescoping screen (5.5') with k-packer.

Padlock ID No. P592 Location of key(s) Hill AFB Bioengineer (6) Radian (3), CDI (1), USTL (1)

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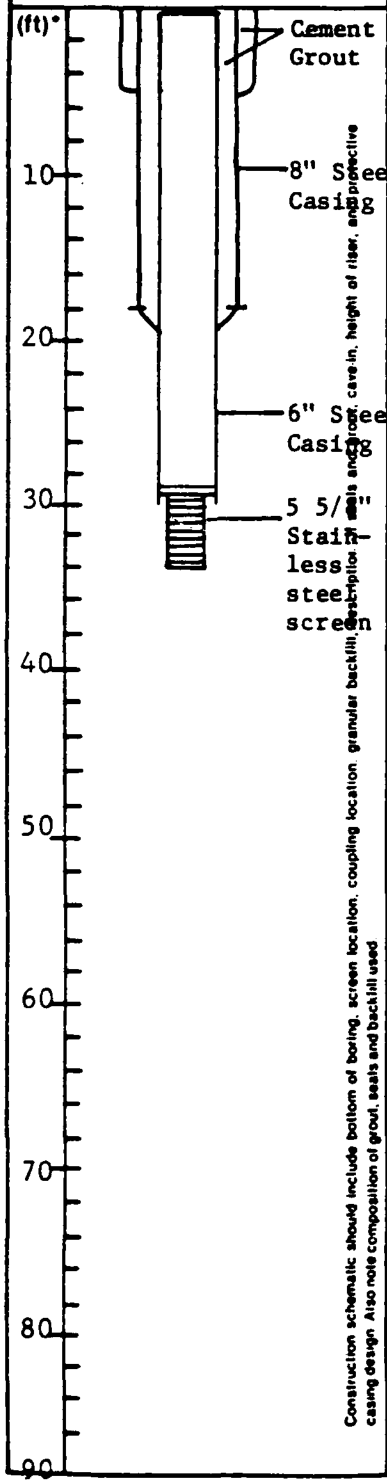
RADIAN CORPORATION

Well Completion Log: Sheet 2/2

Sheet 2 of 2

Boring or Well No. M-10
Project Hill AFB IRP Phase II
Location Landfill No. 3 Area
Log Recorded By R. Belan
Corresponding Tape # --

Construction Schematic



Static level of water before 16.9 (ft) and after ____ (ft) development ____

Development started ____

Development ended ____

Quantity of water discharged during development ____ (ft^3)

Type, size/capacity of pump or bailer used for development ____

Depth of open hole inside well ____

Before development 34.0 (ft)

After development 33.8 (ft)

Development Summary

The ground water discharged during primary development had an average field temperature of 10.1°C ranging from 8.0 C to 11.5°C. Conductivity measurements averaged 680 μmhos/cm ranging from 600 to 750 μmhos/cm. Measured pH values averaged 7.0 and ranged from 6.5 to 8.1. Initial ground-water discharges were initially clear turning muddy/cloudy as the water level drew down. The muddy/cloudy appearance diminished by the end of development.

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RADIAN CORPORATION

Well Completion Log: Sheet 1/2

Sheet 1 of 2

Boring or Well No. GC-1

Location HAFB Golf Course

Project Hill AFB IRP Phase II

Log Recorded By R. Belar

Corresponding Tape # --

Construction started 12/4/82 completed 12/15/82

Total depth drilled (ft) 62

Hole diameter (ft) ~6 1/2-inch

Drilling method Air rotary with casing drive

Problems encountered during drilling Rig broke down; extreme winter weather delayed drilling operations; casing refusal ~50 ft.; heaving sands precluded screen setting which got ~~stuck~~.

Water source for drilling and completion procedures Hill AFB potable system

Number and type of samples collected None

Sample interval (ft-ft) --

Storage method(s) --

Casing type Steel Diameter (ft) 0.56 (6 3/4")

Depth of casing (ft) 48.5 (6 3/4-inch)

Screen type Open hole in casing Diameter (ft) --

Slot size -- Screen interval (ft-ft) None

Type(s) of glue used to join casing none; welded

Type of gravel pack used None

Amount of gravel pack used --

Grain size distribution of gravel pack --

Lithology of gravel pack --

Source (company and quarry/pit) --

Interval of gravel pack (ft-ft) --

Interval of bentonite seal (ft-ft) --

Interval of grouting (ft-ft) 0-5

Description of security measures Plastic compression plug with locking wing nut.

Padlock ID No. P592 Location of key(s) Hill AFB Bioengineer (6)
Radian (3), CDI (1), USTL (1)

RADIAN CORPORATION

Sheet 2 of 2

Well Completion Log: Sheet 2/2

Boring or Well No. GC-1

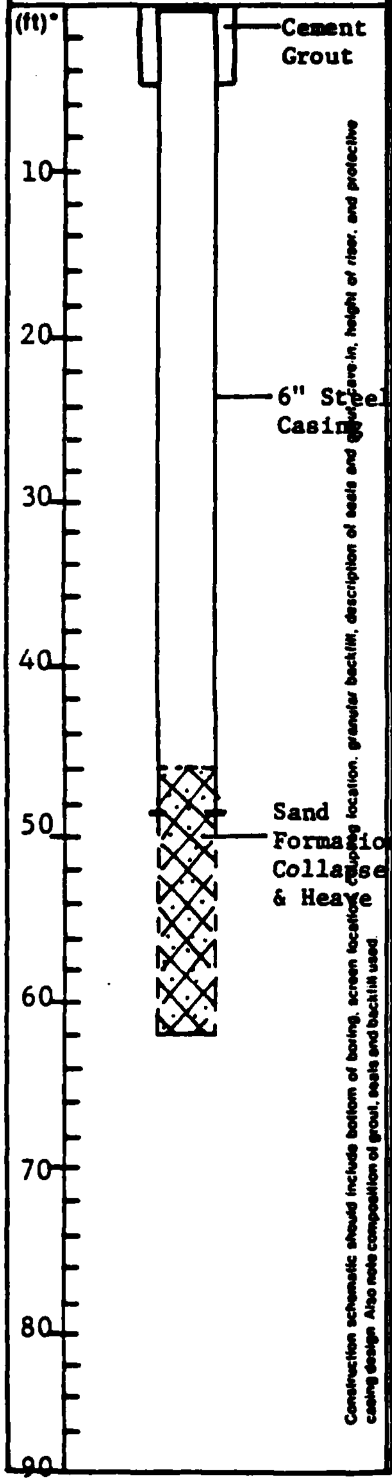
Location HAFB Golf Course

Project Hill AFB IRP Phase II

Log Recorded By R. Belan

Corresponding Tape # --

Construction Schematic



Static level of water before 41.7 (ft)* and after 39.7 (ft)* development

Development started 11/12/82

Development ended 1/12/83

Quantity of water discharged during development 1.5 (ft^3)*

Type, size/capacity of pump or bailer used for development 3" x 2.7' PVC ball valve bailer; capacity: 0.08 ft^3

Depth of open hole inside well

Before development 47.6 (ft)*

After development 45.7 (ft)*

Development Summary

The ground water discharged during primary development had an average field temperature of 9.5°C ranging from 9.0°C to 10.5°C. Conductivity measurements averaged 934 µmhos/cm ranging from 800 to 1,100 µmhos/cm. Measured pH values averaged 7.7 and ranged from 7.3 to 8.3. Ground water boils down quickly. Discharge water becomes light reddish brown and muddy, no odors. Discharge did not clear up due to fine silts, sand and clay entering well bore.

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RADIAN CORPORATION

Well Completion Log: Sheet 1/2

Boring or Well No. BPM-1

Location Berman Pond

Project Hill AFB IRP Phase II

Log Recorded By R. Belan

Corresponding Tape # --

Construction started 12/16/82 completed 12/18/82

Total depth drilled (ft) 122 1/2

Hole diameter (ft) ~6 1/2-inch (48'-122½'); 7-inch (0-48')

Drilling method Air rotary with casing drive

Problems encountered during drilling 6" casing slipped below ground level; had to be retrieved; heaving sand made screen setting difficult.

Water source for drilling and completion procedures Hill AFB potable system, used water to clean casing and provided hydraulic head to help set casing (all should have been removed during development by CDI with rig).

Number and type of samples collected Air rotary composite (4) for visual examination and potential chemical analysis.

Sample interval (ft-ft) 0-1; 10-12; 15-18 (CDI); 30-35

Storage method(s) Ice chest and Bioenvironmental Engineer refrigerator.

Casing type Steel Diameter (ft) 0.56 (6 3/4")

Depth of casing (ft) 109.3 (6 3/4-inch) 29 (8 5/8-inch)

Screen type Stainless steel[1/] Diameter (ft) 0.5 (5 5/8-inch)

Slot size 0.010-inch Screen interval (ft-ft) 108 ~ 113

Type(s) of glue used to join casing none; welded

Type of gravel pack used None

Amount of gravel pack used --

Grain size distribution of gravel pack --

Lithology of gravel pack --

Source (company and quarry/pit) --

Interval of gravel pack (ft-ft) --

Interval of bentonite seal (ft-ft) --

Interval of grouting (ft-ft) 0-5; 0 ~ 29 (annulus)

Description of security measures Plastic compression plug with locking wing nut.

NOTE: 1/ Johnson telescoping screen (5.5') with k-packer.

Padlock ID No. P592 Location of key(s) Hill AFB Bioengineer (6) Radian (3), CDI (1), USTL (1)

RADIAN CORPORATION

Well Completion Log: Sheet 2/2

Sheet 2 of 2

Boring or Well No. BPM-1

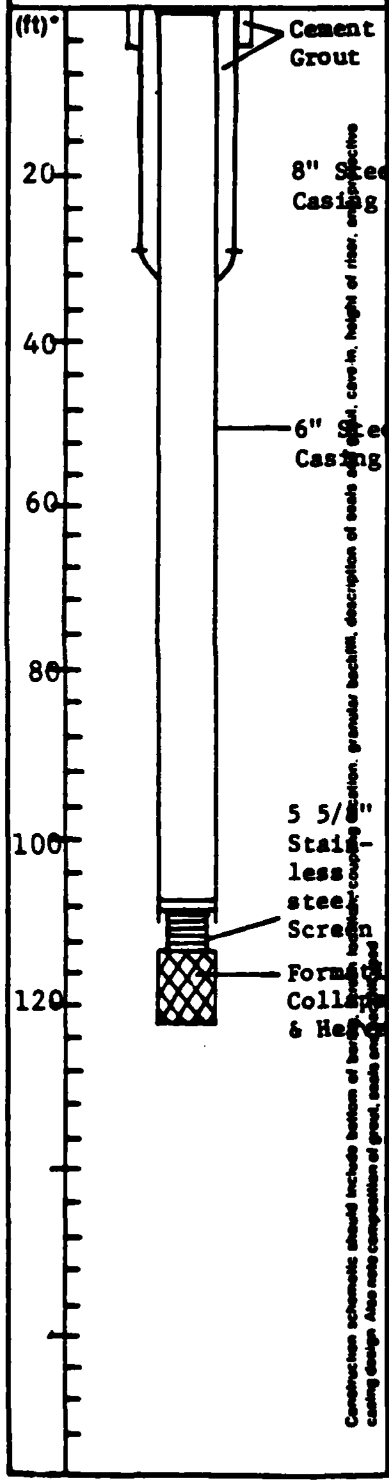
Project Hill AFB IRP Phase II

Location Berman Pond

Log Recorded By R. Belan

Corresponding Tape # --

Construction Schematic



Static level of water before 95.5 (ft) and after 96.4 (ft) development

Development started 1/13/83

Development ended 1/14/83

Quantity of water discharged during development ~1.0 (ft^3)

Type, size/capacity of pump or bailer used for development 3" x 2.7' PVC ball valve bailer; capacity: 0.08 ft^3.

Depth of open hole inside well

Before development ~113 screen set (ft)

After development 103.2 (ft)

Development Summary

The ground water discharged during primary development had an average field temperature of 11.1°C ranging from 11.0°C to 11.5°C. Conductivity measurements averaged 276 μmhos/cm ranging from 230 to 315 μmhos/cm. Measured pH values averaged 7.4 and ranged from 7.1 to 7.6. Water discharge was muddy reddish-brown during developmend due to formation silts, sands and clays that entered through well screen. Water level drew down very quickly and recovered very slowly.

RADIAN CORPORATION

Well Completion Log: Sheet 1/2

Sheet 1 of 2

Boring or Well No. BPM-2

Location Berman Pond

Project Hill AFB IRP Phase II

Log Recorded By R. Belar

Corresponding Tape # --

Construction started 12/20/82 completed 12/20/82

Total depth drilled (ft) 91

Hole diameter (ft) ~6 1/2-inch (~25'-84.7); ~7-inch (0 ~ 25')

Drilling method Air rotary with casing drive

Problems encountered during drilling 6" casing slipped below ground level, CDI had to retrieve it.

Water source for drilling and completion procedures Hill AFB potable system

Number and type of samples collected Air rotary composite (3) for visual examination and potential chemical analysis.

Sample interval (ft-ft) 10-12; 20-22; 23-25

Storage method(s) Ice chest and Bioenvironmental Engineer refrigerator.

Casing type Steel Diameter (ft) 0.56 (6 3/4"); 0.72 (8 5/8")

Depth of casing (ft) 84.7 (6 3/4-inch) 1/ 29 (8 5/8-inch)

Screen type Stainless steel 2/ Diameter (ft) 0.5 (5 5/8-inch)

Slot size 0.010-inch Screen interval (ft-ft) 84.7-89.7

Type(s) of glue used to join casing none; welded

Type of gravel pack used None

Amount of gravel pack used --

Grain size distribution of gravel pack --

Lithology of gravel pack --

Source (company and quarry/pit) --

Interval of gravel pack (ft-ft) --

Interval of bentonite seal (ft-ft) --

Interval of grouting (ft-ft) 0-5; 0 ~ 29 (annulus)

Description of security measures Plastic compression plug with locking wing nut.

1/ 6-inch casing with driveshoe.

2/ Johnson telescoping screen (5.5') with k-packer.

Padlock ID No. P592 Location of key(s) Hill AFB Bioengineer (6) Radian (3), CDI (1), USTL (1)

RADIAN CORPORATION

Sheet 2 of 2

Well Completion Log: Sheet 2/2

Boring or Well No. BPM-2

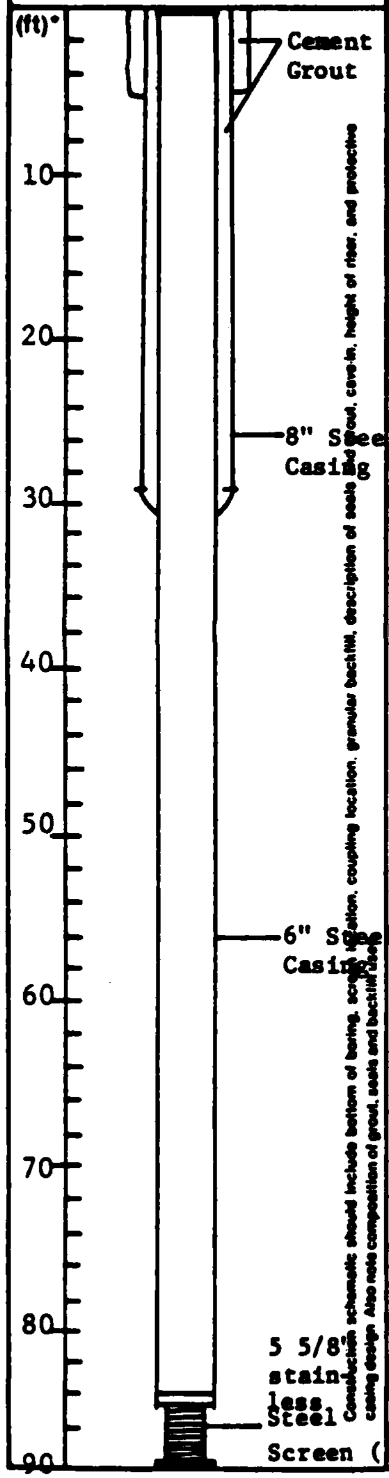
Project Hill AFB IRP Phase II

Location Berman Pond

Log Recorded By R. Belan

Corresponding Tape # --

Construction Schematic



Static level of water before 61.8 (ft) and after 56.9 (ft) development

Development started 1/12/83

Development ended 1/14/83

Quantity of water discharged during development 4.8 (ft^3)

Type, size/capacity of pump or bailer used for development 3" x 2.7' PVC ball valve bailer: capacity: 0.08 ft.^{3}

Depth of open hole inside well

Before development 89.7 (ft)

After development -- (ft)

Development Summary

The ground water discharged during primary development had an average field temperature of 11.8°C ranging from 11.4°C to 12.0°C. Conductivity measurements averaged 440 μmhos/cm ranging from 400 to 490 μmhos/cm. Measured pH values averaged 7.2 and ranged from 6.4 to 7.6. Ground water discharge was mainly clear with occasional cloudiness. No odors detected. The formation was very productive.

RADIAN CORPORATION

Well Completion Log: Sheet 1/2

Sheet 1 of 2

Boring or Well No. P-1

Location Chemical Disposal Pit No. 3

Project Hill AFB IRP Phase II

Log Recorded By R. Belan

Corresponding Tape # --

Construction started 1/6/83 completed 1/6/83

Total depth drilled (ft) 26.0

Hole diameter (ft) ~6 1/2-inch (0-24.5); 2-inch (24.5-26.0)

Drilling method Hollow-stem auger

Problems encountered during drilling Gravel pack siezed casing requiring casing pullout and reseting of PVC materials; no obvious contamination encountered.

Water source for drilling and completion procedures None

Number and type of samples collected 1 - Split-spoon soil sample collected for chemical analysis remainder for viewing.

Sample interval (ft-ft) 20.5-22.0; 7.0-7.5; 20.0-20.5, 24.5-26.0 TD

Storage method(s) Ice chest and Bioenvironmental Engineer refrigerator.

Casing type PVC Diameter (ft) 0.2 (2-inch)

Depth of casing (ft) 23.8

Screen type Hand slotted last 7',2 sides Diameter (ft) 0.2 (2-inch)

Slot size 1/8"x2" @ 1/2' intervals Screen interval (ft-ft) 16.8-23.8

Type(s) of glue used to join casing None, pressure fitted casing

Type of gravel pack used ~1/8" washgravel

Amount of gravel pack used ~8 1/2 gallons

Grain size distribution of gravel pack --

Lithology of gravel pack Mixed

Source (company and quarry/pit) Earth Exploration and Drilling

Interval of gravel pack (ft-ft) ~ 12-24.5 (6½"), 24.5-26.0 (2")

Interval of bentonite seal (ft-ft) 5 ≈ 12 (Volclay and cuttings)

Interval of grouting (ft-ft) 0-5

Description of security measures Steel casing with locking lugs.

Padlock ID No. P592 Location of key(s) Hill AFB Bioengineer (6) Radian (3), CDI (1), UBTL (7)

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RADIAN CORPORATION

Sheet 2 of 2

Well Completion Log: Sheet 2/2

Boring or Well No. P-1

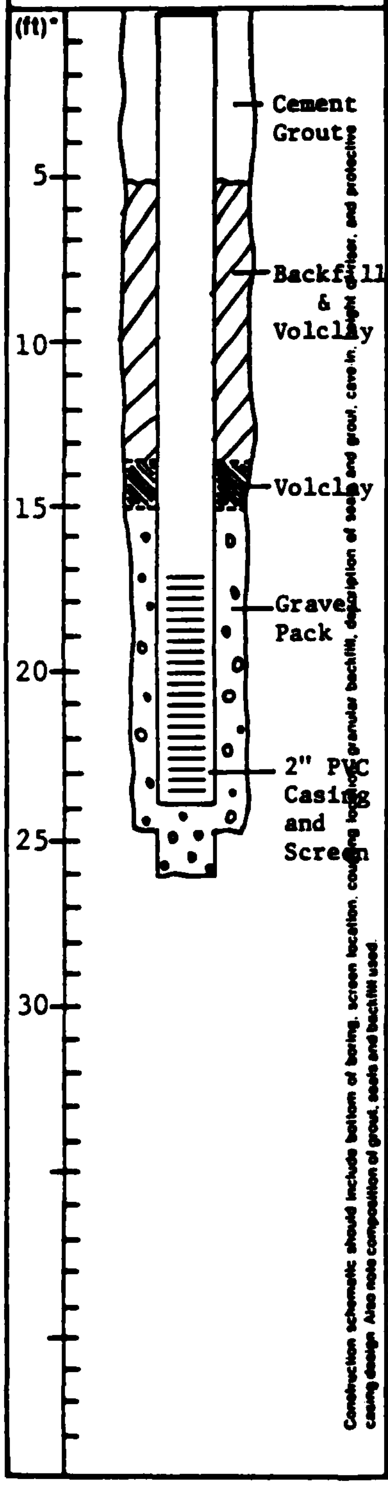
Location Chemical Disposal Pit No. 3

Project Hill AFB IRP Phase II

Log Recorded By R. Belan

Corresponding Tape # --

Construction Schematic



Static level of water before 18.7 (ft) and after 17.7 (ft) development

Development started 1/25/83

Development ended 2/7/83

Quantity of water discharged during development 0.5 (ft^3)

Type, size/capacity of pump or bailer used for development 1 7/16" x 4.0' PVC ball valve bailer; capacity: 0.05 ft^3

Depth of open hole inside well

Before development 23.8 (ft)

After development 22.0 (ft)

Development Summary

The ground water discharged during primary development had an average field temperature of 11°C ranging from 10.8°C to 12.0°C. Conductivity measurements averaged 560 μmhos/cm ranging from 550 to 600. Measured pH values ranged from 6.5 to 7.7 (?) and averaged 7.2. Water was mostly clear but turned reddish as bailed level approached bottom of piezometer. Nothing unusual was noted during bailings.

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RADIAN CORPORATION

Well Completion Log: Sheet 1/2

Boring or Well No. P-2

Location Chemical Disposal Pit No. 3

Project Hill AFB IRP Phase II

Log Recorded By R. Belan

Corresponding Tape # --

Construction started 1/6/83 completed 1/10/83

Total depth drilled (ft) 36.0

Hole diameter (ft) ~6 1/2-inch

Drilling method Hollow-stem auger

Problems encountered during drilling 2-inch PVC got stuck in auger flights; had to pull out and reset materials; no obvious contamination encountered.

Water source for drilling and completion procedures None

Number and type of samples collected 1 - Split-spoon soil sample collected for chemical analysis and viewing.

Sample interval (ft-ft) 19.0-20.5

Storage method(s) Ice chest and Bioenvironmental Engineer refrigerator.

Casing type PVC Diameter (ft) 0.2 (2-inch)

Depth of casing (ft) 36.0

Screen type Hand slotted last 9'.2 sides Diameter (ft) 0.2 (2-inch)

Slot size 1/8"x2" @ 1/2' intervals Screen interval (ft-ft) 25.0-36.0

Type(s) of glue used to join casing None, pressure fitted casing

Type of gravel pack used ~1/8" wash gravel

Amount of gravel pack used --

Grain size distribution of gravel pack --

Lithology of gravel pack Mixed

Source (company and quarry/pit) Earth Exploration and Drilling

Interval of gravel pack (ft-ft) ~25-36

Interval of bentonite seal (ft-ft) ~24-25

Interval of grouting (ft-ft) 0-4

Description of security measures Steel casing with locking lugs.

Padlock ID No. P592 Location of key(s) Hill AFB Bioengineer (6) Radian (3), CDI (1), UBTL (7)

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RADIAN CORPORATION

Sheet 2 of 2

Well Completion Log: Sheet 2/2

Boring or Well No. P-2

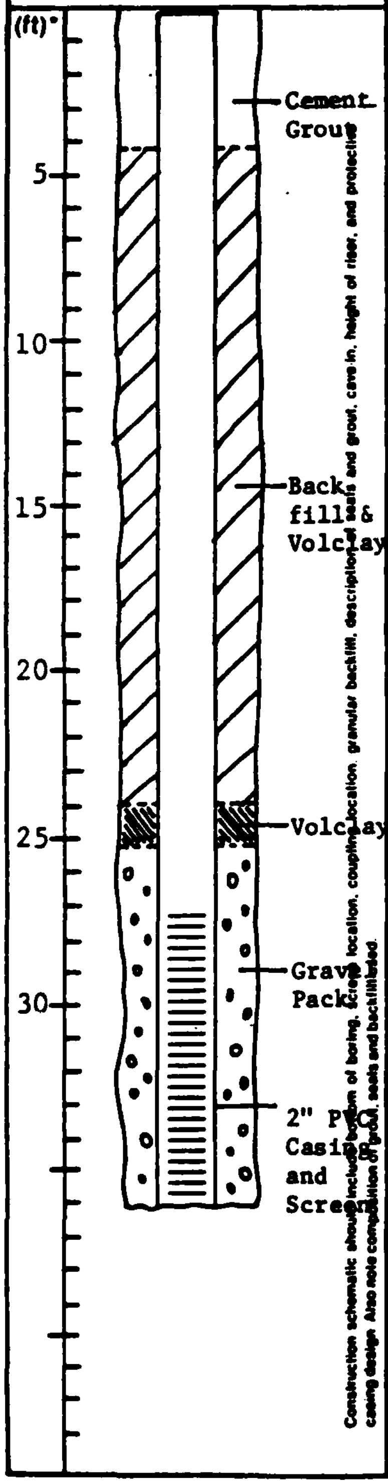
Location Chemical Disposal Pit No. 3

Project Hill AFB IRP Phase II

Log Recorded By R. Eelan

Corresponding Tape # --

Construction Schematic



Static level of water before 30.8 (ft) and after 21.9 (ft) development

Development started 1/25/83

Development ended 2/7/83

Quantity of water discharged during development 1.1 (ft^3)

Type, size/capacity of pump or bailer used for development 1 7/16" x 4.0' PVC ball valve bailer; capacity: 0.05 ft^3

Depth of open hole inside well

Before development 36.0 (ft)

After development 35.5 (ft)

Development Summary

The ground water discharged during primary development had an average field temperature of 11.2°C ranging from 11°C to 12°C. Conductivity measurements averaged 490 μmhos/cm ranging from 420 to 650 μmhos/cm. Measured pH values averaged 6.7, ranging from 6.5 to 6.9. Almost all bail samples field tested were clear but for one that was gray. Nothing unusual was noted during development.

RADIAN CORPORATION

Well Completion Log: Sheet 1/2

Sheet 1 of 2

Boring or Well No. P-3

Location Chemical Disposal Pit No. 3

Project Hill AFB IRP Phase II

Log Recorded By R. Belan

Corresponding Tape # --

Construction started 1/10/83 completed 1/11/83

Total depth drilled (ft) 29.5

Hole diameter (ft) ~6 1/2-inch

Drilling method Hollow-stem auger

Problems encountered during drilling Sandy zones collapse readily; no obvious contamination encountered.

Water source for drilling and completion procedures None

Number and type of samples collected 1 - Split-spoon soil sample(s) collected for chemical analysis remainder for viewing.

Sample interval (ft-ft) 10.0-10.9; 25.0-27.0; 28.0-29.0; 29.0-29.5

Storage method(s) Ice chest and Bioenvironmental Engineer refrigerator.

Casing type PVC Diameter (ft) 0.2 (2-inch)

Depth of casing (ft) 28.6

Screen type Hand slotted last 5',2 sides Diameter (ft) 0.2 (2-inch)

Slot size 1/8"x2" @ 1/2' intervals Screen interval (ft-ft) 23.6-28.6

Type(s) of glue used to join casing None, pressure fitted casing

Type of gravel pack used ~1/8-inch washed gravel

Amount of gravel pack used ~10 gallons

Grain size distribution of gravel pack --

Lithology of gravel pack Mixed

Source (company and quarry/pit) Earth Exploration and Drilling

Interval of gravel pack (ft-ft) ~22-28.6

Interval of bentonite seal (ft-ft) ~12-13

Interval of grouting (ft-ft) 0-5

Description of security measures Steel casing with locking lugs.

Padlock ID No. P592 Location of key(s) Hill AFB Bioengineer (6) Radian (3), CDI (1), UBTL (7)

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RADIAN CORPORATION

Well Completion Log: Sheet 2/2

Boring or Well No. P-3

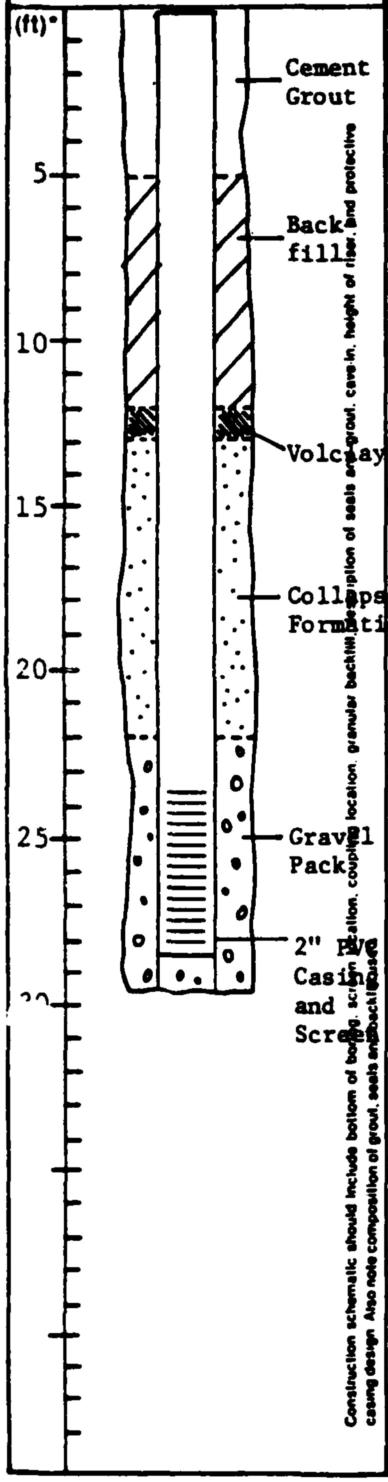
Project Hill AFB IRP Phase II

Location Chemical Disposal Pit No. 3

Log Recorded By R. Belan

Corresponding Tape # --

Construction Schematic



Static level of water before 10.2 (ft) and after 8.9 (ft) development

Development started 1/25/83

Development ended 2/7/83

Quantity of water discharged during development 2.0 (ft^3)

Type, size/capacity of pump or bailer used for development 1 7/16" x 4.0' PVC ball valve bailer; capacity: 0.05 ft^3

Depth of open hole inside well

Before development 28.6 (ft)

After development 24.1 (ft)

Development Summary

The ground water discharged during primary development had an average field temperature of 9.8°C ranging from 8.5°C to 11.0°C. Conductivity measurements average 700 μmhos/cm ranging from 700 to 710 μmhos/cm. Measured pH values averaged 6.9 and ranged from 6.2 to 7.3. Most bail samples were clear with some gray as water level drew down to bottom. Nothing unusual was noted during development.

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RADIAN CORPORATION

Well Completion Log: Sheet 1/2

Sheet 1 of 2

Boring or Well No. P-4

Location Chemical Disposal Pit No. 3

Project Hill AFB IRP Phase II

Log Recorded By R. Belan

Corresponding Tape # --

Construction started 1/11/83 completed 1/12/83

Total depth drilled (ft) 18

Hole diameter (ft) ~6 1/2-inch

Drilling method Hollow-stem auger

Problems encountered during drilling Sandy zones collapsed readily; no obvious contamination encountered.

Water source for drilling and completion procedures None

Number and type of samples collected None

Sample interval (ft-ft) N/A

Storage method(s)

Casing type PVC Diameter (ft) 0.2 (2-inch)

Depth of casing (ft) 17.4

Screen type Hand slotted last 5', 2 sides Diameter (ft) 0.2 (2-inch)

Slot size 1/8"x2" @ 1/2' intervals Screen interval (ft-ft) 12.4-17.4

Type(s) of glue used to join casing None, pressure fitted casing

Type of gravel pack used ~1/8-inch washed gravel

Amount of gravel pack used 5 gallons

Grain size distribution of gravel pack --

Lithology of gravel pack Mixed

Source (company and quarry/pit) Earth Exploration and Drilling

Interval of gravel pack (ft-ft) ~12-17.4 gravel pack/natural formation

Interval of bentonite seal (ft-ft) ~11-12

Interval of grouting (ft-ft) 0-5

Description of security measures Steel casing with locking lugs.

Padlock ID No. P592 Location of key(s) Hill AFB Bioengineer (6) Radian (3), CDI (1), UBTL (7)

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RADIAN CORPORATION

Sheet 2 of 2

Well Completion Log: Sheet 2/2

Boring or Well No. P-4

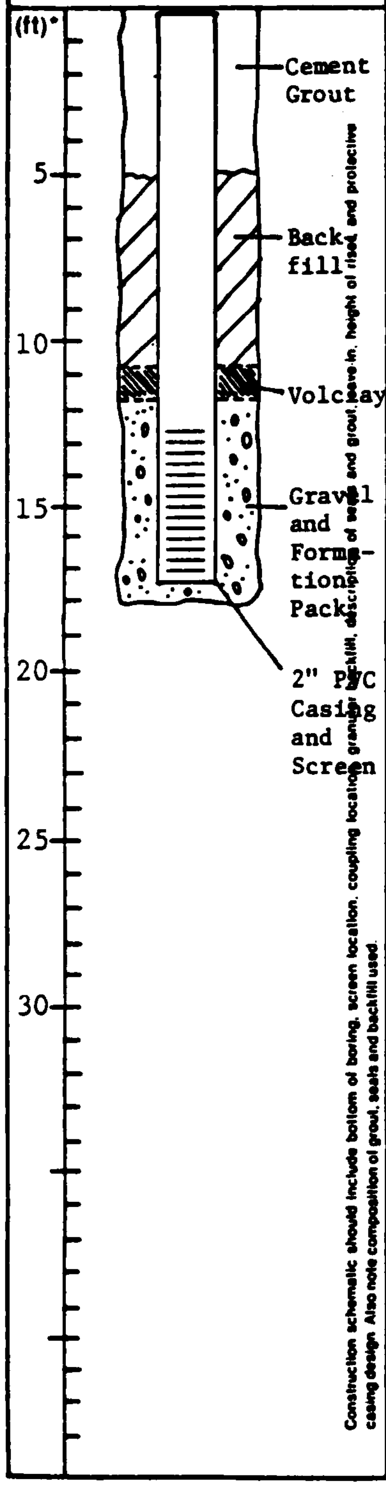
Project Hill AFB IRP Phase II

Location Chemical Disposal Pit No. 3

Log Recorded By R. Belan

Corresponding Tape # --

Construction Schematic



Static level of water before 10.0 (ft) and after 8.2 (ft) development

Development started 1/25/83

Development ended 2/7/83

Quantity of water discharged during development 0.5 (ft^3)

Type, size/capacity of pump or bailer used for development 1 7/16" x PVC ball valve bailer; capacity: 0.05 ft^3.

Depth of open hole inside well

Before development 17.4 (ft)

After development 16.4 (ft)

Development Summary

The ground water discharged during primary development had an average field temperature of 9.2°C ranging from 9.0°C to 10.0°C. Conductivity measurements averaged 750 μmhos/cm ranging from 600 to 800 μmhos/cm. Measured pH values averaged 6.7 and ranged from 6.5 to 7.0. Initial bailed water samples were clear becoming reddish by the end of the days bailing cycle. Nothing unusual was noted during development.

RADIAN CORPORATION

Well Completion Log: Sheet 1/2

Sheet 1 of 2

Boring or Well No. P-5

Project Hill AFB IRP Phase II

Location Chemical Disposal Pit No. 3

Log Recorded By R. Belan

Corresponding Tape # --

Construction started 1/12/83 completed 1/13/83

Total depth drilled (ft) 50.4

Hole diameter (ft) ~6 1/2-inch

Drilling method Hollow-stem auger

Problems encountered during drilling Large clay section greatly slowed auger operations; no obvious contamination encountered.

Water source for drilling and completion procedures None

Number and type of samples collected 1 - Split-spoon soil sample(s) collected for chemical analysis remainder for viewing.

Sample interval (ft-ft) 17.5-19.3; 20.5-22.1; 40.0-41.8; 45.0-46.0; 50.0-51.3 TD

Storage method(s) Ice chest and Bioenvironmental Engineer refrigerator.

Casing type PVC Diameter (ft) 0.2 (2-inch)

Depth of casing (ft) 50.4

Screen type Hand slotted last 3',2 sides Diameter (ft) 0.2 (2-inch)

Slot size 1/8"x2" @ 1/2' intervals Screen interval (ft-ft) 47.4-50.4

Type(s) of glue used to join casing None, pressure fitted casing

Type of gravel pack used ~1/8" washed gravel

Amount of gravel pack used ~9 gallons; 2 1/2 gallons on backfilling

Grain size distribution of gravel pack --

Lithology of gravel pack Mixed

Source (company and quarry/pit) Earth Exploration and Drilling

Interval of gravel pack (ft-ft) 45.4-50.4

Interval of bentonite seal (ft-ft) 44.9-45.4; periodically on backfilling

Interval of grouting (ft-ft) 0-4

Description of security measures Steel casing with locking lugs.

Padlock ID No. P592

Location of key(s) Hill AFB Bioengineer (6) Radian (3), CDI (1), UBTL (7)

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RADIAN CORPORATION

Sheet 2 of 2

Well Completion Log: Sheet 2/2

Boring or Well No. P-5

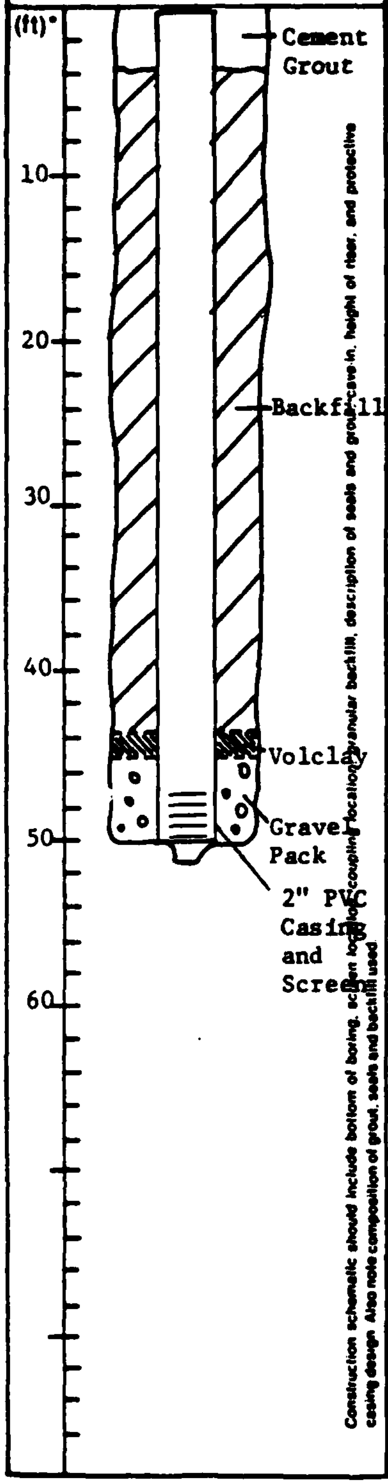
Location Chemical Disposal Pit No. 3

Project Hill AFB IRP Phase II

Log Recorded By R. Belan

Corresponding Tape # --

Construction Schematic



Construction schematic should include bottom of boring, screen location, coupling location, annular backfill, description of seals and grout, cave-in, height of riser, and protective casing design. Also note composition of grout, seals and backfill used

Static level of water before 48.7 (ft) and after 20.3 (ft) development

Development started 1/25/83

Development ended 2/7/83

Quantity of water discharged during development 3.9 (ft^3)

Type, size/capacity of pump or bailer used for development 1 7/16" x 4.0' PVC ball valve bailer; capacity: 0.05 ft^3.

Depth of open hole inside well

Before development ~50.1 (ft)

After development 49.3 (ft)

Development Summary

The ground water discharged during primary development had an average field temperature of 10.4°C ranging from 10.0°C to 12.0°C. Conductivity measurements averaged 380 μmhos/cm ranging from 550 to 630 μmhos/cm. Measured pH values averaged 7.4 and ranged from 6.9 to 8.0. All bailed samples were noted as clear. Nothing unusual was noted during development.

RADIAN CORPORATION

Well Completion Log: Sheet 1/2

Sheet 1 of 2

Boring or Well No. P- 6

Project Hill AFB IRP Phase II

Location Chemical Disposal Pit No. 3

Log Recorded By R. Belan

Corresponding Tape # --

Construction started 1/25/83 completed 1/26/83

Total depth drilled (ft) ∿40

Hole diameter (ft) ∿6 1/2-inch

Drilling method Hollow-stem auger

Problems encountered during drilling Encountered solvents @ ∿20 ft.; sands easily collapse and heave which stuck auger bit.

Water source for drilling and completion procedures HAFB potable water; used ∿100 gallons# to maintain hydraulic head in augers for emplacing PVC; scattered Volclay on ground to absorb GW/solvent moisture.

Number and type of samples collected 3 - Split-spoon soil sample(s) collected for chemical analysis remainder for viewing.

Sample interval (ft-ft) 5.0-5.7; 19.0-20.4; 20.5-21.5; 22.0-23.5; 23.5-25.2

Storage method(s) Ice chest and Bioenvironmental Engineer refrigerator.

Casing type PVC Diameter (ft) 0.2 (2-inch)

Depth of casing (ft) 40.0

Screen type Hand slotted last 5',2 sides Diameter (ft) 0.2 (2-inch)

Slot size 1/8"x2" @ 1/2' intervals Screen interval (ft-ft) 35.0-40.0

Type(s) of glue used to join casing None, pressure fitted casing

Type of gravel pack used None

Amount of gravel pack used --

Grain size distribution of gravel pack --

Lithology of gravel pack --

Source (company and quarry/pit) --

Interval of gravel pack (ft-ft) None - natural formation used.*

Interval of bentonite seal (ft-ft) ∿16-17; ∿9.5-10.0; scattered on ground

Interval of grouting (ft-ft) 0-5

Description of security measures Steel casing with locking lugs.

NOTES:

∿100 gallons ground water bailed to waste prior to first sampling.

* The heaving sands prevented emplacement of an artificial gravel pack.

Padlock ID No. P592 Location of key(s) Hill AFB Bioengineer (6) Radian (3), CDI (1), UBTL (7)

RADIAN CORPORATION

Well Completion Log: Sheet 2/2

Sheet 2 of 2

Boring or Well No. P-6

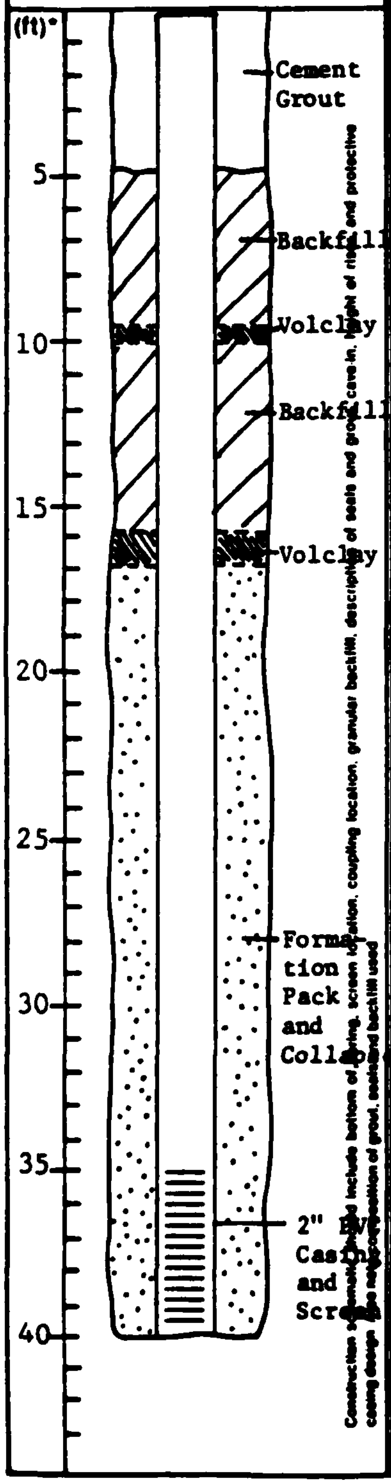
Project Hill AFB IRP Phase II

Location Chemical Disposal Pit No. 3

Log Recorded By R. Belan

Corresponding Tape # --

Construction Schematic



Static level of water before 21.0 (ft) and after 19.9 (ft)* development

Development started 1/31/83

Development ended 2/7/83

Quantity of water discharged during development 13.3 (ft^3)

Type, size/capacity of pump or bailer used for development 1 7/16" x 4.0' PVC ball valve bailer; capacity: 0.05 ft^3.

Depth of open hole inside well

Before development ~40.0 (ft)

After development 34.6 (ft)

Development Summary

The ground water discharged during primary development had an average field temperature of 10.8°C ranging from 10.5°C to 11.0°C. Conductivity measurements averaged 850 µmhos/cm ranging from 750 to 950 µmhos/cm. Measured pH values averaged 6.7 and ranged from 6.6 to 6.8. Bailed water samples were mostly clear turning slightly murky as water level drew down. Solvent odors from the ground water were noted during development.

RADIAN CORPORATION

Well Completion Log: Sheet 1/2

Sheet 1 of 2

Boring or Well No. P-7

Location Chemical Disposal Pit No. 3

Project Hill AFB IRP Phase II

Log Recorded By R. Belan

Corresponding Tape # --

Construction started 1/26/83 completed 2/1/83

Total depth drilled (ft) 32 (hollow-stem auger); 33.0 (split-spoon)

Hole diameter (ft) ~6 1/2-inch

Drilling method Hollow-stem auger

Problems encountered during drilling Solvent smells encountered; PVC broke near surface required reconstruction of piezometer.

Water source for drilling and completion procedures None

Number and type of samples collected 3 - Split-spoon soil sample(s) collected for chemical analysis remainder for viewing.

Sample interval (ft-ft) 4.5-5.8; 14.0-15.8; 29.0-31.0; 31.8-32.0; 32.0-33.0; 29.0-31.5 (Shelby)

Storage method(s) Ice chest and Bioenvironmental Engineer refrigerator.

Casing type PVC Diameter (ft) 0.2 (2-inch)

Depth of casing (ft) ~33.0

Screen type Hand slotted last 5',2 sides Diameter (ft) 0.2 (2-inch)

Slot size 1/8"x2" @ 1/2' intervals Screen interval (ft-ft) 28.0~33.0

Type(s) of glue used to join casing None, pressure fitted casing

Type of gravel pack used 3/8-inch (minus) pea gravel, exposed aggregate

Amount of gravel pack used ~9 1/2 gallons

Grain size distribution of gravel pack --

Lithology of gravel pack Mixed

Source (company and quarry/pit) Ideal Rock Products, South Weber, Utah

Interval of gravel pack (ft-ft) 26.5-32.0

Interval of bentonite seal (ft-ft) 26.0-26.5

Interval of grouting (ft-ft) 0-7

Description of security measures Steel casing with locking lugs.

Padlock ID No. P592 Location of key(s) Hill AFB Bioengineer (6) Radian (3), CDI (1), UBTL (7)

5 81 3579

RADIAN CORPORATION

Sheet 2 of 2

Well Completion Log: Sheet 2/2

Boring or Well No. P- 7

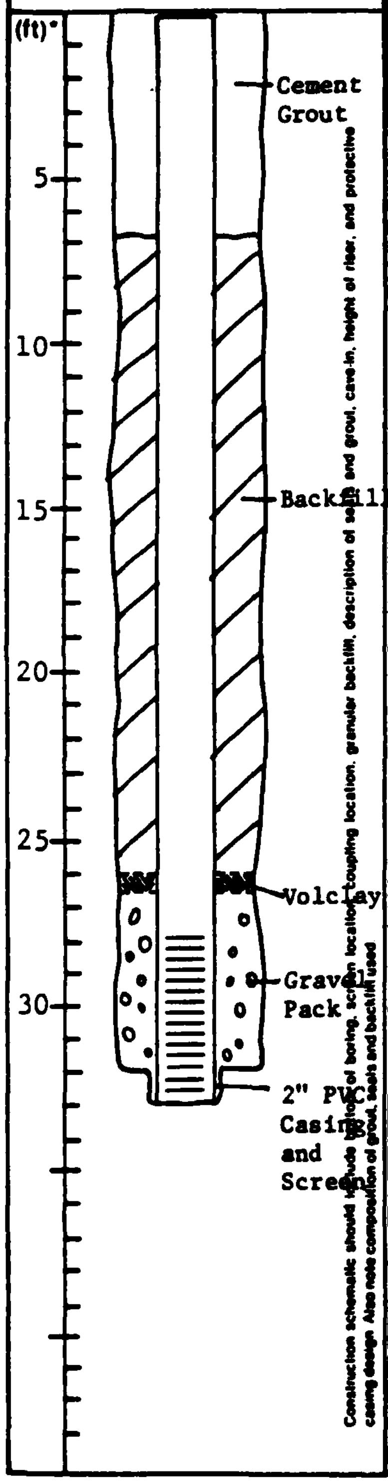
Project Hill AFB IRP Phase II

Location Chemical Disposal Pit No. 3

Log Recorded By R. Belan

Corresponding Tape # --

Construction Schematic



Static level of water before 21.1 (ft) and after 16.4 (ft) development

Development started 1/28/83

Development ended 2/7/83

Quantity of water discharged during development 2.7 (ft^3)

Type, size/capacity of pump or bailer used for development 1 7/16" x 4.0' PVC ball valve bailer; capacity: 0.05 ft^3.

Depth of open hole inside well

Before development ~33.0 (ft)

After development 33.0 (ft)

Development Summary

The ground water discharged during primary development had an average field temperature of 11.5°C ranging from 11.0°C to 12.0°C. Conductivity measurements averaged 1,060 μmhos/cm ranging from 720 to 1,400 μmhos/cm. Measured pH value was 6.6. Bailed water samples were mostly clear and early in development turned murky red as the water level declined. Solvent odors from the ground water were noted during development.

RADIAN CORPORATION

Well Completion Log: Sheet 1/2

Sheet 1 of 2

Boring or Well No. P-8

Location Chemical Disposal Pit No. 3

Project Hill AFB IRP Phase II

Log Recorded By R. Belan

Corresponding Tape # --

Construction started 1/27/83 completed 1/28/83

Total depth drilled (ft) 46

Hole diameter (ft) ~4 1/2-inch

Drilling method Solid-stem auger

Problems encountered during drilling Sand intervals collapsed easily requiring completing a deeper piezometer than planned.

Water source for drilling and completion procedures None

Number and type of samples collected 1 - Split-spoon soil sample(s) collected for chemical analysis remainder for viewing.

Sample interval (ft-ft) 5.0-6.0; 45.0-45.8; 45.8-46.0

Storage method(s) Ice chest and Bioenvironmental Engineer refrigerator.

Casing type PVC Diameter (ft) 0.2 (2-inch)

Depth of casing (ft) 41.5

Screen type Hand slotted last 8',2 sides Diameter (ft) 0.2 (2-inch)

Slot size 1/8"x2" @ 1/2' intervals Screen interval (ft-ft) 33.5-41.5

Type(s) of glue used to join casing None, pressure fitted casing

Type of gravel pack used 3/8-inch (minus) pea gravel, exposed aggregate

Amount of gravel pack used ~6 gallons

Grain size distribution of gravel pack --

Lithology of gravel pack Mixed

Source (company and quarry/pit) Ideal Rock Products, South Weber, Utah

Interval of gravel pack (ft-ft) ~32.5-41.5

Interval of bentonite seal (ft-ft) ~31.0-32.5

Interval of grouting (ft-ft) 0-5

Description of security measures Steel casing with locking lugs.

Padlock ID No. P592 Location of key(s) Hill AFB Bioengineer (6) Radian (3), CDI (1), UBTL (7)

5 81 35/9

RADIAN CORPORATION

Sheet 2 of 2

Well Completion Log: Sheet 2/2

Boring or Well No. P-8

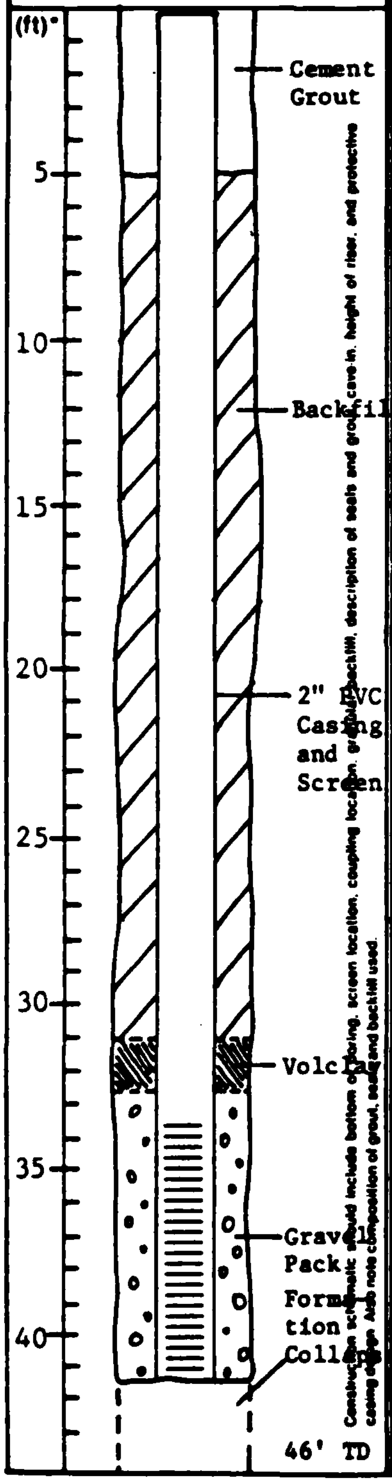
Location Chemical Disposal Pit No. 3

Project Hill AFB IRP Phase II

Log Recorded By R. Belan

Corresponding Tape # --

Construction Schematic



Static level of water before 23.4 (ft) and after 22.7 (ft) development

Development started 1/28/83

Development ended 2/7/83

Quantity of water discharged during development 1.0 (ft^3)

Type, size/capacity of pump or bailer used for development 1 7/16" x 4.0' PVC ball valve bailer; capacity: 0.05 ft^3.

Depth of open hole inside well

Before development 41.5 (ft)

After development 37.1 (ft)

Development Summary

The ground water discharged during primary development had an average field temperature of 10.8°C ranging from 10.0°C to 11.0°C. Conductivity measurements averaged 510 µmhos/cm ranging from 500 to 550 µmhos/cm. Measured pH values averaged 6.9 and ranged from 6.4 to 7.3. Initial water samples clear turning gray as water level declines to bottom. By the end of development the ground water tended to stay clearer longer.

RADIAN CORPORATION

Sheet 1 of 2

Well Completion Log: Sheet 1/2

Boring or Well No. P- 9

Location Chemical Disposal Pit No. 3

Project Hill AFB IRP Phase II

Log Recorded By R. Belan

Corresponding Tape # --

Construction started 1/28/83 completed 1/28/83

Total depth drilled (ft) 28.5 (6 1/2-inch), 28.5-30.0 (2-inch split-spoon)

Hole diameter (ft) ~6 1/2-inch

Drilling method Hollow-stem auger

Problems encountered during drilling --

Water source for drilling and completion procedures None

Number and type of samples collected 1 - Split-spoon soil sample to confirm clay.

Sample interval (ft-ft) 28.5-30.0

Storage method(s) Ice chest and Bioenvironmental Engineer refrigerator.

Casing type PVC Diameter (ft) 0.2 (2-inch)

Depth of casing (ft) 27.9

Screen type Hand slotted last 3', 2 sides Diameter (ft) 0.2 (2-inch)

Slot size 1/8"x2" @ 1/2' intervals Screen interval (ft-ft) 24.9-27.9

Type(s) of glue used to join casing None, pressure fitted casing

Type of gravel pack used 3/8-inch (minus) pea gravel, exposed aggregate.

Amount of gravel pack used ~3 gallons

Grain size distribution of gravel pack --

Lithology of gravel pack Mixed

Source (company and quarry/pit) Ideal Rock Products, South Weber, Utah

Interval of gravel pack (ft-ft) ~24.9-27.9

Interval of bentonite seal (ft-ft) 18.0-18.5

Interval of grouting (ft-ft) 0-4

Description of security measures Steel casing with locking lugs.

Padlock ID No. P592 Location of key(s) Hill AFB Bioengineer (6)
Radian (3), CDI (1), UBTL (7)

5 81 3579

RADIAN CORPORATION

Sheet 2 of 2

Well Completion Log: Sheet 2/2

Boring or Well No. P- 9

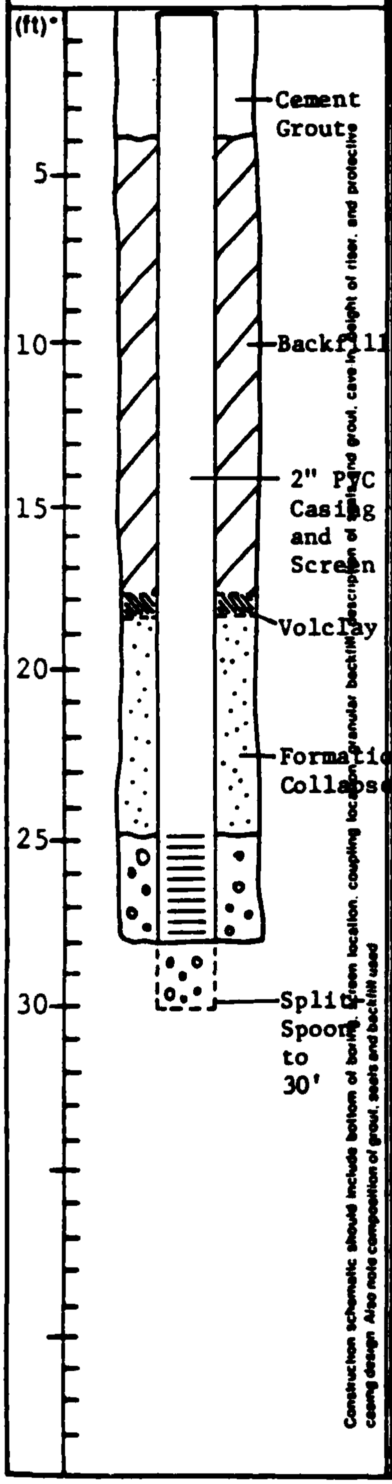
Project Hill AFB IRP Phase II

Location Chemical Disposal Pit No. 3

Log Recorded By R. Belan

Corresponding Tape # --

Construction Schematic



Static level of water before 22.1 (ft) and after 21.4 (ft) development

Development started 1/29/83

Development ended 2/7/83

Quantity of water discharged during development 2.5 (ft^3)

Type, size/capacity of pump or bailer used for development 1 7/16" x 4.0' PVC ball valve bailer; capacity: 0.05 ft^3.

Depth of open hole inside well

Before development 27.9 (ft)

After development 26.9 (ft)

Development Summary

The ground water discharged during primary development had an average field temperature of 10.5°C ranging from 10.0°C to 11.0°C. Conductivity measurements averaged 470 µmhos/cm ranging from 450 to 525 µmhos/cm. Measured pH values averaged 6.7 and ranged from 6.4 to 6.8. Early bailed water was clear which turned reddish as water level quickly declined.

5 81 35 79

RADIAN CORPORATION

Well Completion Log: Sheet 1/2

Sheet 1 of 2

Boring or Well No. P- 10

Location Chemical Disposal Pit No. 3

Project Hill AFB IRP Phase II

Log Recorded By R. Belan

Corresponding Tape # --

Construction started 1/28/83 completed 1/28/83

Total depth drilled (ft) 28 (6 1/2 inch); 28-29.6 (2-inch split-spoon)

Hole diameter (ft) ~6 1/2-inch

Drilling method Hollow-stem auger

Problems encountered during drilling Encountered solvent smelling soils

Water source for drilling and completion procedures None

Number and type of samples collected 4 - Split-spoon soil sample(s) collected for chemical analysis remainder for viewing.

Sample interval (ft-ft) 5.0-6.4; 10.0-10.5; 15.0-16.3; 25.0-26.2; 28.0-29.6

Storage method(s) Ice chest and Bioenvironmental Engineer refrigerator

Casing type PVC Diameter (ft) 0.2 (2-inch)

Depth of casing (ft) 25.5*

Screen type Western Plastics prefab.scrn Diameter (ft) 0.2 (2-inch)

Slot size ~1/64"x1-5/8"@~84 ft. Screen interval (ft-ft) 20.5-25.5

Type(s) of glue used to join casing None, pressure fitted casing

Type of gravel pack used None - natural formation used.

Amount of gravel pack used --

Grain size distribution of gravel pack --

Lithology of gravel pack --

Source (company and quarry/pit) --

Interval of gravel pack (ft-ft)

Interval of bentonite seal (ft-ft) ~18-22**

Interval of grouting (ft-ft)

Description of security measures Steel casing with locking lugs.

NOTES: * Purpose was to screen at a higher level than the screen at nearby P-6.

** Some Volclay may be across screen.

Padlock ID No. P592 Location of key(s) Hill AFB Bioengineer (6) Radian (3), CDI (1), UBTL (7)

RADIAN CORPORATION

Sheet 2 of 2

Well Completion Log: Sheet 2/2

Boring or Well No. P-10

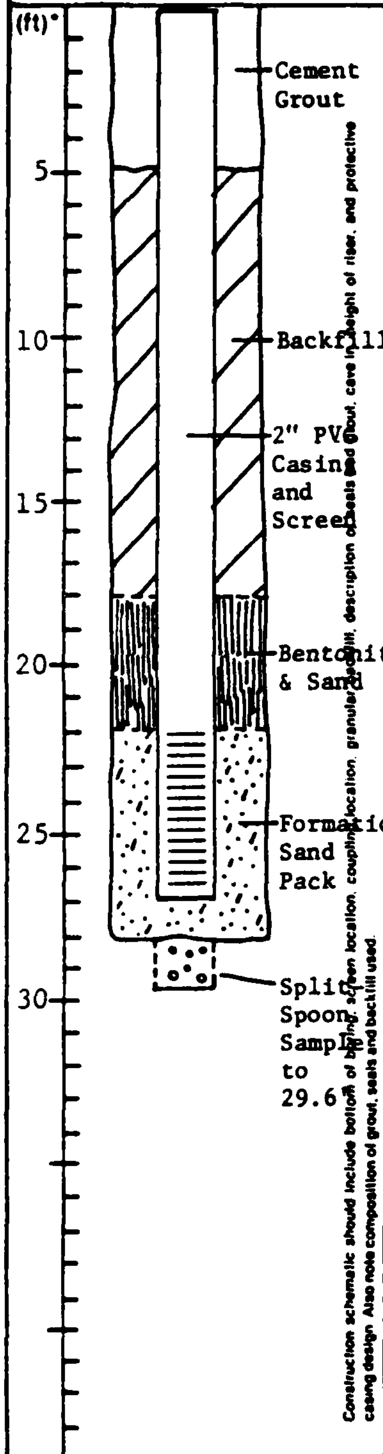
Project Hill AFB IRP Phase II

Location Chemical Disposal Pit No. 3

Log Recorded By R. Belan

Corresponding Tape # --

Construction Schematic



Construction schematic should include bottom of boring, screen location, coupling location, granular backfill, description of seals and grout, cave in, height of riser, and protective casing design. Also note composition of grout, seals and backfill used.

Static level of water before 23.9 (ft) and after 23.2 (ft) development

Development started 1/31/83

Development ended 2/7/83

Quantity of water discharged during development 0.1 (ft^3)

Type, size/capacity of pump or bailer used for development 1 7/16" x 4.0' PVC ball valve bailer; capacity: 0.05 ft^3.

Depth of open hole inside well

Before development ~26.9 (ft)

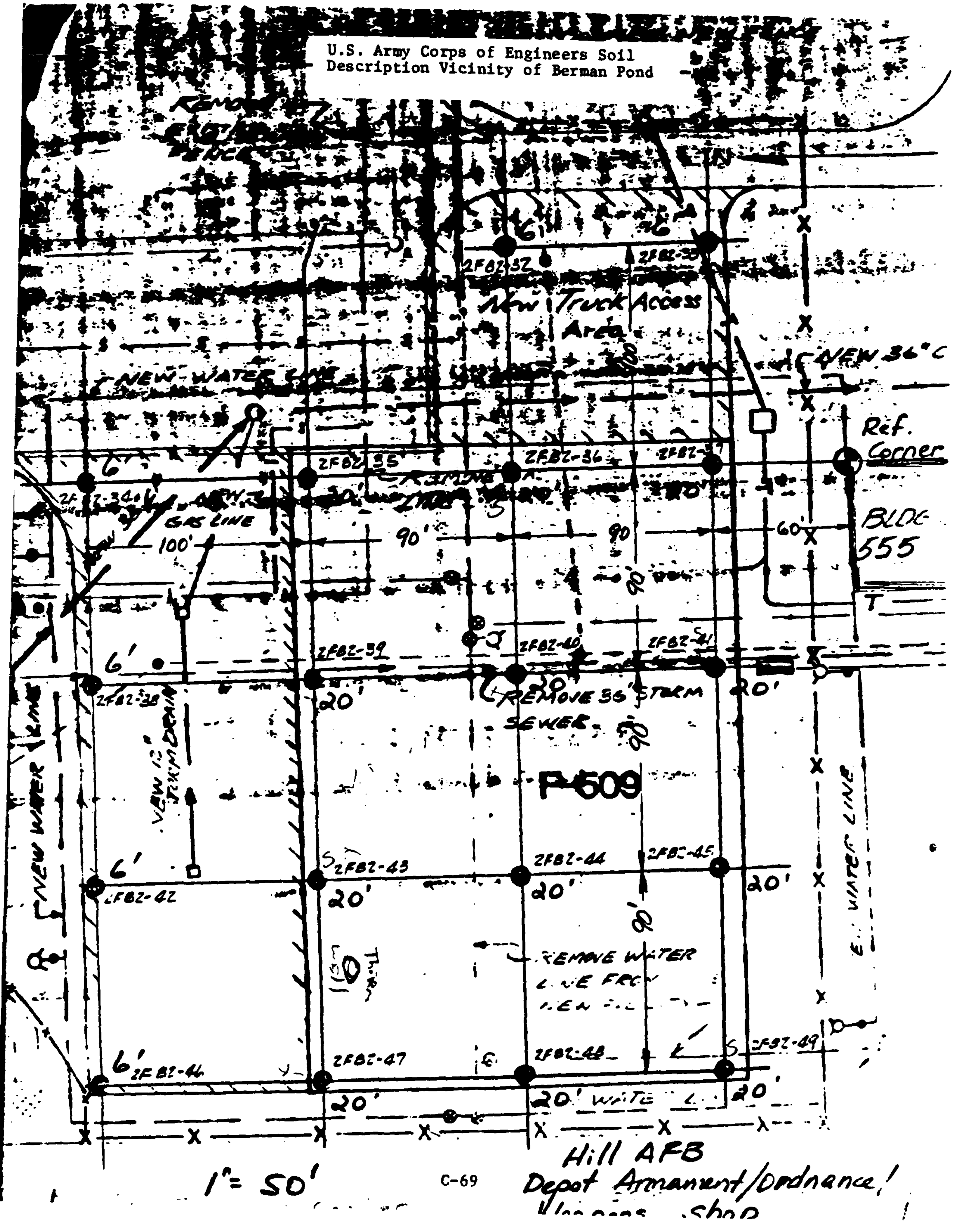
After development 26.7 (ft)

Development Summary

The ground water discharged during primary development had an average field temperature of 11.3°C ranging from 11.0°C to 11.5°C. Conductivity measurements averaged 890 µmhos/cm ranging from 720 to 1,050 µmhos/cm. Measured pH values were not available. Water level quickly drew down to the bottom. Discharge colored red with silt.

5 81 3579

U.S. Army Corps of Engineers Soil Description Vicinity of Berman Pond



Hole No. 2F-82-32

DRILLING LOG	DIVISION: South Pacific	INSTALLATION: USAED Sacramento	SHEET 1 OF 1 SHEETS
1. PROJECT: Depot Oil/Acm Weapons Shop		10. SIZE AND TYPE OF BIT: 7" Hollow Stem Auger	
2. LOCATION (Coordinates or Station): Hill AFB		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
3. DRILLING AGENCY: Rollins Brown & Gunnell		12. MANUFACTURER'S DESIGNATION OF DRILL: CME 55 + Std Penetrometer	
4. HOLE NO. (As shown on drawing title and file number): 2F-82-32		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED / UNDISTURBED
5. NAME OF DRILLER: Tom Snow		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE: [x] VERTICAL [ ] INCLINED ___ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
		16. DATE HOLE: STARTED Nov 1 1982; COMPLETED Nov 1 1982	
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE	
8. DEPTH DRILLED INTO ROCK		18. TOTAL CORE RECOVERY FOR BORING %	
9. TOTAL DEPTH OF HOLE: 6 Ft		19. SIGNATURE OF INSPECTOR: [signature]	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS d	BOX OR SAMPLE NO. e	% RECOVERY f	H_2O g	Dr h	REMARKS i
	.5	3 / 3 / 6	Organic Silty Sand Black, Very Fine Sand, Organic Mat Roots Etc					
	1.5 – 2		Clayey Sand, Brown Moist, Very Fine to Fine Sand Low Plastic Fines					
	2 – 3	6 / 15 / 15	Silty Gravelly Sand Brown Moist Fine Grained Sub Angular Sand, Rounded Gravels To 2 inch					
	3 – 6	5 / 4 / 5	Silty Sand, Dark Brown Moist Very Fine To Fine Grained					

ENG FORM 1836-R 1 APR 63 PREVIOUS EDITIONS MAY BE USED (EM 1110-2-1801)

Local reproduction authorized 19 Jun 67

PROJECT: Depot Oil/Acm Weapons Shop Hill AFB | HOLE NO. 2F-82-32

Hole No. 2F-82-53

DRILLING LOG | South Pacific | SHEET 1 of 1 SHEETS

INSTALLATION: SACRAMENTO

1. PROJECT: Depot Ord/Arm Weapons Shop

2. LOCATION: Hill AFB

3. DRILLING AGENCY: Rollins Brown & Gunnell

4. HOLE NO.: 2F-82-53

5. NAME OF DRILLER: Tom Snow

6. DIRECTION OF HOLE: [X] VERTICAL

9. TOTAL DEPTH OF HOLE: 6 FT

10. SIZE AND TYPE OF BIT: 7" Hollow Stem Auger

12. MANUFACTURER'S DESIGNATION OF DRILL: CME 55 + Std Penetrometer

16. DATE HOLE: STARTED Nov 1 1982 | COMPLETED Nov 1 1982

19. SIGNATURE OF INSPECTOR: [signature]

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS	BOX OR SAMPLE NO.	% RECOVERY	H_2O	Wx	REMARKS
	.5	4	LAYERS OF BROWN + BLACK sandy silt DAMP, ORGANIC MAT ROOTS ETC					
		4						
	1	8	Sandy Clay, Brown Damp Very Fine Sand Med Plastic Organic Mat Roots ETC					
	1.5							
	2	7	Brown silty sand moist very fine to fine sand					
	2.5	14	Brown silty sand Brown, moist very fine to fine grained Rounded grains ...					
	3	19						
	3.5							
	4		Silty sand Brown Damp very fine to fine grained					
	4.5	9						
	5	10						
	5.5	12						
	6		BOH					

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ENG FORM 1836-R 4 APR 63 | PROJECT: Depot Ord/Arm Weapons Shop Hill AFB | HOLE NO. 2F82-53

Local reproduction authorized 29 Jan 67

Hole No. ZF-82-34

DRILLING LOG | DIVISION: South Pacific | INSTALLATION: USAED Sacramento | SHEET 1 OF 1 SHEETS

1. PROJECT: Dept Ord/Arm Weapons Shop
2. LOCATION (Coordinates or Station): Hill AFB
3. DRILLING AGENCY: Rollins Brown & Gunnell
4. HOLE NO. (As shown on drawing title and file number): ZF-82-34
5. NAME OF DRILLER: Tom Snow
6. DIRECTION OF HOLE: [x] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 6 FT
10. SIZE AND TYPE OF BIT: 7" Hollow Stem Auger
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: CME 55 & Std Penetrometer
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE | STARTED: Oct 29, 1982 | COMPLETED: Oct 29, 1982
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR: [signature]

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS d	BOX OR SAMPLE NO. e	% RECOVERY f	H_2O g	Dr h	REMARKS i
		7	Organic silty sand, black, damp, very fine to fine sand, organics					
	.5	16	Gravelly silty sand, brown, damp, [illegible] gravels to 1½ inch					
	1	16						
	1.5	/	Silty sand, brown, damp, fine [illegible] [illegible]					
	2							
	2.5	5						
		7						
	3	7						
	3.5	/						
			Silty sand, brown, moist, very fine to fine sand					
		3						
		/						
	6		TD					

ENG FORM 1836-R 1 APR 63 PREVIOUS EDITIONS MAY BE USED (ER 1110-1-1801)
Local reproduction authorized 10 Jun 67

PROJECT: Dept Ord/Arm Weapons Shop Hill AFB | HOLE NO. ZF-82-34

Hole No. 2F-82-35

DRILLING LOG | DIVISION: South Pacific | INSTALLATION: McClellan AFB / Sacramento (written "McClellan AFB(?) Sacramento") | SHEET 1 of 2 SHEETS

1. PROJECT: Diesel Drill/Arm Weapons Shop
2. LOCATION (Coordinates or Station): Hill AFB
3. DRILLING AGENCY: Rollins Brown & Gunnell
4. HOLE NO. (As shown on drawing title and file number): 2F-82-35
5. NAME OF DRILLER: Tom S[illegible]
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ___ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 20 FT
10. SIZE AND TYPE OF BIT: 7" Hollow Stem Auger
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: CME 55 & std Penetrometer
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED: 9 | UNDISTURBED:
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED: Nov 1 1982 | COMPLETED: Nov 1 1982
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR: [signature]

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS d	BOX OR SAMPLE NO. e	% RECOVERY f	H_2O g	γ_d h	REMARKS i
	0.5	6	Organic silty sand, brown, damp, very F to F sand, organic mat roots etc					FS#1 0.0 TO 0.5
	1 / 1.5	12 / 16	Clayey gravelly sand, brown, damp, V.F.-F. sand, rounded gravel to 2 inch					FS#2 0.5 TO 1.5; note gravels in test boring cont'd -
	2 / 2.5 / 3 / 3.5	7 / 11 / 10 / 11 / 7	Silty sand, dark brown, moist, very fine to fine sand					FS#3 1.5 TO 4.0
	4.5 / 5 / 5.5 / 6 / 6.5	4 / 4 / 6 / 7 / 3 / 4	Brown silty sand, moist, very fine to fine grained, 40% fines					FS#4 4.2 TO 7.2
	7 / 7.5	5 / 7	Sandy silt, brown, damp, very fine sand					FS#5 7.2 TO 8.2
	8 / 8.5 / 9 / 9.5 / 10	5 / 6 / 10 / 7	Silty sand, brown, damp, very fine to fine grained					FS#6 8.0 TO 10.5

ENG FORM 1836-R (1 APR 63) PREVIOUS EDITIONS MAY BE USED

Local reproduction authorized 30 Jun 67

PROJECT: Diesel Drill/Arm Weapons Shop Hill AFB | HOLE NO. 2F-82-35

Hole No. 2 F-82-35

DRILLING LOG | S L | Spects | SHEET 2 of 2 SHEETS

1. PROJECT: Depot OAP/ARP weapons shop
2. LOCATION: Hill AFB
4. HOLE NO.: 2 F-82-35
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: 9
16. DATE HOLE: STARTED Nov 1 1982 | COMPLETED Nov 1 1982
19. SIGNATURE OF INSPECTOR: [illegible]
9. TOTAL DEPTH OF HOLE: 20 FT

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS	BOX OR SAMPLE NO.	% CORE RECOVERY			REMARKS
		7	AS ABOVE					
	10.5 – 11.5	8, 11	Slightly silty sand Brown, Damp very Fine to Fine Sub Angular grained mostly Sand					FS#7 10.5 TO 11.5
	12 – 14.5	5, 11, 16, 5	AS ABOVE					
	14.5 – 15.5	7, 13	Gravelly sand, Brown Damp Fine To medium subangular sand rounded Gravel To 3/4 inch					FS#8 14.5 TO 15.5
	15.5 – 17.5	10, 14, 19	Sand, Gray Brown Damp, very Fine To Fine grained Iron stained Layers					FS#9 15.5 TO
	18 – 20	12, 18, 24	AS ABOVE					

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Hole No. 2F-82-36

DRILLING LOG	DIVISION South Pacific	INSTALLATION USAED Sacramento	SHEET 1 OF 2 SHEETS

1. PROJECT: Depot ord/arm weapons shop
2. LOCATION (Coordinates or Station): Hill AFB
3. DRILLING AGENCY: Rolling Brown + Gravel
4. HOLE NO. (As shown on drawing title and file number): 2F-82-36
5. NAME OF DRILLER: Tom Snow
6. DIRECTION OF HOLE: [x] VERTICAL [ ] INCLINED ___ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN:
8. DEPTH DRILLED INTO ROCK:
9. TOTAL DEPTH OF HOLE: 22 Ft

10. SIZE AND TYPE OF BIT: T Hollow Stem Ams 5"
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL: CME 55 + Std Penetrometer
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: | DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES:
15. ELEVATION GROUND WATER:
16. DATE HOLE: STARTED Nov 1 1982 | COMPLETED Nov 1 1982
17. ELEVATION TOP OF HOLE:
18. TOTAL CORE RECOVERY FOR BORING: %
19. SIGNATURE OF INSPECTOR: [signature]

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS d	BOX OR SAMPLE NO. e	% RECOVERY f	H_2O g	Dr h	REMARKS i
	0.5	3, 8, 12, 12	Clayey Gravelly sand Brown Damp, very fine to fine sand Rounded gravels to 1½ inch, Low % Fines					
	1, 1.5, 2							
	2.5, 3	17, 14	Silty Sand, Dark Brown, moist very fine to fine sand					note Rock effected blow count
	3.5, 4, 4.5	4, 5	Silty Sand, Brown moist, very fine to fine sand					
	5, 5.5, 6, 6.5	5, 6, 6						
	7, 7.5, 8	11	Sandy silt Light Brown Damp, very fine sand					
	8.5, 9, 9.5, 10	5, 9, 11	Slightly silty sand Damp Brown very fine to fine sand					

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ENG FORM 1836-R 1 APR 63 PREVIOUS EDITIONS MAY BE USED (EM 1110-1-1801)
Local reproduction authorized 19 Jun 67

PROJECT: Depot ord/arm weapons shop Hill AFB | HOLE NO. 2F-82-36

HOLE NO. 2F-32-36

DRILLING LOG	DIVISION SP	INSTALLATION Sacto	SHEET 2 OF 2 SHEETS

1. PROJECT: Depot ORL/ABR weapons Shop
2. LOCATION: Hill AFB
3. DRILLING AGENCY:
4. HOLE NO.: 2F-32-36
5. NAME OF DRILLER:
6. DIRECTION OF HOLE: VERTICAL
7. THICKNESS OF OVERBURDEN:
8. DEPTH DRILLED INTO ROCK:
9. TOTAL DEPTH OF HOLE: 20 FT
10. SIZE AND TYPE OF BIT:
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL:
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN:
14. TOTAL NUMBER CORE BOXES:
15. ELEVATION GROUND WATER:
16. DATE HOLE: STARTED NOV 1 1982 COMPLETED NOV 1 1982
17. ELEVATION TOP OF HOLE:
18. TOTAL CORE RECOVERY FOR BORING: %
19. SIGNATURE OF INSPECTOR: [signature]

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS	BOX OR SAMPLE NO.	% RECOVERY	REMARKS
	10.5 – 12.5	7, 12, 11	SAnd AS ABOVE			
	12.5 – 16	13, 18, 13, 15, 13	Silty SAnd, Brown Damp Fine To med Sub-angular sand rounded gravels to [illegible]. AS ABOVE			
	16 – 16.5	12	SAnd Brown Damp Fine grained			
	16.5 – 20	21, 30, 9, 10, 20	Silty SAnd, Brown Damp very Fine sand A layer of sandy silt + Iron staining – Low % Fines. AS ABOVE			
	20		BOH			

ENG FORM 1836-R 1 APR 68 PREVIOUS EDITIONS MAY BE USED (ER 1110-2-1801) | PROJECT: Depot ORL/ABR weapons Shop Hill AFB | HOLE NO. 2F-32-36

Local reproduction authorized 10 Jun 67

HOLE NO. 2 FS2-37

DRILLING LOG	DIVISION: South Pacific
INSTALLATION: ALSAES Sacramento	SHEET 1 OF 2 SHEETS
1. PROJECT: Depot AGE/ACM Weapons Shop	10. SIZE AND TYPE OF BIT: 7" Hollow Stem Auger
2. LOCATION (Coordinates or Station): Hill AFB	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY: Rollins Brown + Gunnel	12. MANUFACTURER'S DESIGNATION OF DRILL: CME 55 + std penetrometer
4. HOLE NO. (As shown on drawing title and file number): 2 FS2-37	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN — DISTURBED: 9 — UNDISTURBED:
5. NAME OF DRILLER: Tom Snow	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE — STARTED: Nov 1 1982 — COMPLETED: Nov 1 1982
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE: 10 Ft	19. SIGNATURE OF INSPECTOR: [signature]

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS d	BOX OR SAMPLE NO. e	% RECOVERY f	H_2O g	Wz h	REMARKS i
	.5	4	Organic silty sand, Dark Brown, moist, VF-F sand, organic mat roots etc					FS#1 0-TO 0.5
	1	6	Gravely sand, Brown, moist, fine sand, formed of gravels to 2 inch, thin layers of clayey sand —					FS#2 0.5 TO 4.0
	1.5	5						
	2	14						
	2.5	19						
	3	23						
	4	8	Silty sand, Brown, moist, very fine to fine sand, organic ... mostly sand —					FS#3 4.0 TO 10.0
	4.5	10						
	5	13						
	6	8						
	6.5	7						
	7	9						
	8.5	8						
	9	8	Sand as above					
	9.5	11						
	10							

ENG FORM 1836-R 1 APR 63 PREVIOUS EDITIONS MAY BE USED (EM 1110-1-1801)

Local reproduction authorized 19 Jun 67

PROJECT: Depot AGE/ACM Weapons Shop Hill AFB — HOLE NO. 2 FS2-37

DRILLING LOG	DIVISION SP	INSTALLATION Sacto	SHEET 2 OF 2 SHEETS

1. PROJECT: Depot Ord/Arm Weapons Shop
2. LOCATION (Coordinates or Station): Hill AFB
3. DRILLING AGENCY:
4. HOLE NO. (As shown on drawing title and file number): 2F-82-37
5. NAME OF DRILLER:
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN:
8. DEPTH DRILLED INTO ROCK:
9. TOTAL DEPTH OF HOLE: 20 Ft
10. SIZE AND TYPE OF BIT:
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL:
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 7 | UNDISTURBED
14. TOTAL NUMBER CORE BOXES:
15. ELEVATION GROUND WATER:
16. DATE HOLE: STARTED Apr 1 1982 | COMPLETED Apr 1 1982
17. ELEVATION TOP OF HOLE:
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR:

ELEVATION	DEPTH	LEGEND (blows)	CLASSIFICATION OF MATERIALS	BOX OR SAMPLE NO.	% RECOVERY	H_2O	Wc	REMARKS
	10.5	8	Sandy silt Brown Damp, very fine sand					FS #5 10½ to 11½ FT
	11–12	13	Sand, Brown Damp, very fine to fine sand, mostly fine sand					FS #6 15 to 16
	14.5–15.5	13, 19, 22	As above 10% gravels to ½ inch					
	16–17.5	13, 15, 23	Silty sand, Brown moist, very fine to fine sand, high % v-f sand, some iron staining					FS #7 18 to 20
	18.5–20	13, 20, 32	As above					

BOH

ENG FORM 1836-R 1 APR 63 PREVIOUS EDITIONS MAY BE USED (EM 1110-1-1801)

Local reproduction authorized 19 Jun 67

PROJECT: Depot Ord/Arm Weapons Shop Hill AFB | HOLE NO. 2F82-37

Hole No. 2F-82-38

DRILLING LOG	DIVISION: South Pacific	INSTALLATION: MCSPED Sacramento	SHEET 1 OF 1 SHEETS
1. PROJECT: Depot Arc/Arm Weapons Shop		10. SIZE AND TYPE OF BIT: 7' Hollow Stem Auger	
2. LOCATION (Coordinates or Station): Hill AFB		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
3. DRILLING AGENCY: Rollins Brown & Gunnell		12. MANUFACTURER'S DESIGNATION OF DRILL: CME 55 & std Penetrometer	
4. HOLE NO. (As shown on drawing title and file number): 2F-82-38		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED	
5. NAME OF DRILLER: Tom Snow		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN		16. DATE HOLE: STARTED Oct 29, 1982; COMPLETED Oct 29, 1982	
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE	
9. TOTAL DEPTH OF HOLE: 6 FT		18. TOTAL CORE RECOVERY FOR BORING %	
		19. SIGNATURE OF INSPECTOR: [signature]	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS d	BOX OR SAMPLE NO. e	% RECOVERY f	H_2O g	W_L h	REMARKS i
	0–0.5	6	Gravelly Sand, Dk Brown Fine sand					
	0.5–2.5	7 / 7 / 1 / 3	Brown silty sand moist very fine to fine sand scattered gravels to 3/4 in dia.					
	2.5–6	3 / 3 / 1 / 1 / 4 / 6 / 4	Brown silty sand moist very fine to fine sand low to fines					
			As above					
	6		BOH					

ENG FORM 1836-R (1 APR 63) PREVIOUS EDITIONS MAY BE USED (EM 1110-1-1801)
Local reproduction authorized 19 Jun 67

PROJECT: Depot Arc/Arm Weapons Shop Hill AFB | HOLE NO. 2F-82-38

DRILLING LOG | South Pacific | MSAED Sacramento | 4

1. Depot ADV/AGM weapons shop
2. Hill AFB
3. Rolling Brown & Gunnel
4. 2E-82-39
5. Tom Snow
6. ☒ vertical ☐ inclined
7.
8.
9. Total depth of hole: 20 Ft
10. 7" Hollow Stem Auger
11.
12. CME 55 + Std Penetrometer
13.
14.
15.
16. Oct 29, 1982 | Oct 29, 1982
17.
18.
19.

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS	BOX OR SAMPLE NO.	% RECOVERY			REMARKS
		6	Gravelly silty sand Dark Brown, very fine to fine sand organic mat roots etc. Rounded gravels to 1 inch					
	0.5 – 2.5	8, 7, 3	Silty sand, Brown moist, D-Brown very fine to fine sand scattered gravels to 3/4 inch					
	2.5 – 4.5	3, 4, 4	Silty sand, Brown moist, very fine to fine sand low % fines					
	4.5 – 6.5	3, 4, 5	Silty sand, Brown Damp very fine to fine grained					
	6.5 – 8	7, 10	Sandy silty light Brown Damp, very fine sand					
	8 – 10	6, 8, 11	Slightly silty sand light Brown, Damp very fine to fine g-B angular grained, mostly sand					

ENG FORM 1836-R

Depot Adv/Agm weapons shop Hill AFB | 2E-82-39

Hole No. 2F-82-39

DRILLING LOG	DIVISION SP	INSTALLATION SACTO	SHEET 2 OF 2 SHEETS

1. PROJECT: Depot Ord/Air Weapons Ship
2. LOCATION (Coordinates or Station): Hill AFB
3. DRILLING AGENCY:
4. HOLE NO. (As shown on drawing title and file number): 2F-82-39
5. NAME OF DRILLER:
6. DIRECTION OF HOLE: [x] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN:
8. DEPTH DRILLED INTO ROCK:
9. TOTAL DEPTH OF HOLE: 20 FT
10. SIZE AND TYPE OF BIT:
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL:
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES:
15. ELEVATION GROUND WATER:
16. DATE HOLE: STARTED Oct 29, 1982 | COMPLETED Oct 29, 1982
17. ELEVATION TOP OF HOLE:
18. TOTAL CORE RECOVERY FOR BORING: %
19. SIGNATURE OF INSPECTOR: [illegible]

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS	BOX OR SAMPLE NO.	% RECOVERY	H_2O	Wx	REMARKS
	10.5	5						
	11	9	Slightly silty					
	11.5	14	Sand as					
	12		Above					
	12.5	9						
	13	11						
	13.5	12						
	14							
	14.5	8						
	15	12						
	15.5	19	Silty Sand, light Brown Damp very Fine to Fine Sand					
	16							
	16.5	10	as Above some					
	17	19	Iron Staining					
	17.5	27						
	18							
	18.5		Slightly silty Sand light Brown					
	19	8	Damp very Fine					
	19.5	16	To Fine grained					
	20	24	BOH					

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ENG FORM 1836-R 1 APR 63 PREVIOUS EDITIONS MAY BE USED (EM 1110-1-1801)

Local reproduction authorized 19 Jun 67

PROJECT: Depot Ord/Air Weapons Ship Hill AFB | HOLE NO. 2F-82-39

Hole No. 2F-83-MW

DRILLING LOG	DIVISION: South Pacific	INSTALLATION: USED Sacramento	SHEET 1 OF 2 SHEETS

1. PROJECT: Depot Arm/Ammo Weapons Shop	10. SIZE AND TYPE OF BIT: 7" Hollow Stem auger
2. LOCATION (Coordinates or Station): Hill AFB	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY: Rollins Brown & Gunnel	12. MANUFACTURER'S DESIGNATION OF DRILL: CME 55 w/std penetrometer
4. HOLE NO. (As shown on drawing title and file number): 2F-83-MW	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER: Tom Snow	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE — STARTED: Nov 1 1982 — COMPLETED: Nov 1 1982
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE: 20 Ft	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR: [signature]

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS d	BOX OR SAMPLE NO. e	% RECOVERY f	H_2O g	Ur h	REMARKS i
	0–2	9, 12, 11	Silty Gravelly Sand Brown moist v. fine to fine sand with Gravels to 1½ inch ...					
	2–4.5	4, 5, 6	Silty Sand Brown moist very fine to fine grained ... fines					
	4.5–6	2, 5	Sandy Clay, Brown Damp very ... fine sand with ... fines					
	6–6.5	5	Sandy silt, Brown Damp very fine sand					
	6.5–8	7, 8	Silty Sand, Brown Damp very fine to fine sub angular sand					
	8–10	5, 8, 11	Slightly silty sand, Brown Moist fine grained, ... sand					

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ENG FORM 1836-R 1 APR 63 PREVIOUS EDITIONS MAY BE USED (EM 1110-1-1801)
Local reproduction authorized 19 Jun 67

PROJECT: Depot Arm/Ammo Weapons Shop Hill AFB | HOLE NO. 2F-83-MW

DRILLING LOG	DIVISION SP	INSTALLATION Sacto	SHEET 2 OF 2 SHEETS

1. PROJECT: Depot Air/ammo weapons shop
2. LOCATION (Coordinates or Station): Hill AFB
3. DRILLING AGENCY
4. HOLE NO. (As shown on drawing title and file number): 2 [illegible]
5. NAME OF DRILLER
6. DIRECTION OF HOLE: ☑ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE | STARTED Nov 1 1982 | COMPLETED Nov 1 198[illegible]
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR: [illegible]

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS d	BOX OR SAMPLE NO. e	% RECOVERY f	H_2O g	Wn h	REMARKS i
	10	4, 8	Sandy silty, Brown damp very fine sand, some thin wet layers of clayey sand					
	11	11						
	12	5	Silty sand, Brown damp very fine to fine sand					
	13	12, 16	Gravelly sand, Brown damp, fine to med sub angular grained rounded gravels to 1 inch					
	14	7						
	15	14, 16	Slightly silty sand gray-brown, very fine to fine grained thin layers of [illegible]					
	16	12, 14						
	17	19						
	18	11, 17	Silty sands as above					
	19	17, 22						
	20		BOH					

ENG FORM 1836-R 1 APR 63 PREVIOUS EDITIONS MAY BE USED (EM 1110-1-1801)
Local reproduction authorized 19 Jan 67

PROJECT: Depot Air/ammo weapons shop Hill AFB | HOLE NO. 2[illegible]

DRILLING LOG	South Pacific		Sacramento	Zones

1. PROJECT: Depot Air/ammo weapons shop
2. LOCATION (Coordinates or Station): Hill AFB
3. DRILLING AGENCY: Rollins Brown & Gunnel
4. HOLE NO. (As shown on drawing title and file number): 2F-82-41
5. NAME OF DRILLER: Tom Snow
6. DIRECTION OF HOLE: ☑ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 20 FT

10. SIZE AND TYPE OF BIT: 7" Hollow Stem auger
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: CME 55 + Std Penetrometer
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED Oct 28, 1982 | COMPLETED Oct 28, 1982
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR: [signature]

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS d	BOX OR SAMPLE NO. e	% RECOVERY f	H_2O g	Pu h	REMARKS i
	0.5 – 1	23, 16	Fill Moist Primarily clayey silts + silty sands					
	1.5 – 2	16	Fill as above					
	2.5 – 4.5		Silty sand dark brown moist very fine to fine sand					
	5 – 7.5	3, 5, 6, 9, 5	Silty sand brown moist very fine to fine sand low fines					
	7 – 9.5	5, 7	As above					
	10	16	Gravelly sand brown damp fine to coarse sand gravels to 3/4 inch					

ENG FORM 1836-R 1 APR 63 PREVIOUS EDITIONS MAY BE USED. (EM 1110-1-1801)
Local reproduction authorized 19 Jun 67

PROJECT: Depot Air/ammo weapons shop Hill AFB | HOLE NO. 2F-82-41

DRILLING LOG	DIVISION SLC	INSTALLATION Socto	SHEET 2 OF 2 SHEETS

1. PROJECT: Depot Air/ammo weapons shop
2. LOCATION (Coordinates or Station): Hill AFB
3. DRILLING AGENCY:
4. HOLE NO. (As shown on drawing title and file number): 2F-52-4
5. NAME OF DRILLER:
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN:
8. DEPTH DRILLED INTO ROCK:
9. TOTAL DEPTH OF HOLE: 20 FT
10. SIZE AND TYPE OF BIT:
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL:
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
14. TOTAL NUMBER CORE BOXES:
15. ELEVATION GROUND WATER:
16. DATE HOLE: STARTED Oct 28, 1982 COMPLETED Oct 28, 1982
17. ELEVATION TOP OF HOLE:
18. TOTAL CORE RECOVERY FOR BORING: %
19. SIGNATURE OF INSPECTOR: [illegible]

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS d	BOX OR SAMPLE NO. e	% RECOVERY f	H_2O g	γ_d h	REMARKS i
	10.5							
	11	4	Slightly silty sand Brown Damp. Very Fine to Fine sand Scattered gravel to 1/2 inch					
	11.5	8						
	12	12						
	12.5							
	13	12	Gravelly sand Brown [illegible] Fine [illegible]					
	13.5	14	[illegible]					
	14							
	14.5		Slightly silty (Dirty) Sand Very Fine to Fine sand [illegible] [illegible]					
	15							
	15.5							
	16							
	16.5							
	17	9						
	17.5	16						
	18	25						
	18.5							
	19	9	Sands as Above					
	19.5	17						
	20	23	BOH					

ENG FORM 1 APR 63 1836-R PREVIOUS EDITIONS MAY BE USED (EM 1110-1-1801) | PROJECT: Depot Air/ammo weapons shop Hill AFB | HOLE NO. 2F-52-4

Local reproduction authorized 19 Jun 67

DRILLING LOG	[illegible] South Pacific	[illegible] USAED Sacramento	[illegible] 1 of 2 [illegible]
1. [illegible] Depot Armament/Ordnance		10. [illegible] 7" Hollow Stem Auger	
2. [illegible] Hill AFB		11. [illegible]	
3. [illegible] Rollins, Brown & Gunnell		12. [illegible] CME #55 Std. Penetrometer	
4. [illegible] 2FB2-43		13. [illegible]	7
5. [illegible] Tom Snow		14. [illegible]	
6. [illegible] ☒ [illegible] ☐ [illegible]		15. [illegible]	
7. [illegible]		16. [illegible]	Oct 28, 1982 / Oct 29, 1982
8. [illegible]		17. [illegible]	
9. [illegible] 20 ft		18. [illegible]	
		19. [illegible] [signature]	

[illegible] a	[illegible] b	[illegible] c	CLASSIFICATION OF MATERIALS d	[illegible] SAMPLE NO. e	[illegible] RECOVERY f	H_2O g	[illegible] h	[illegible] i
	0, .5, 1, 1.5	4, 3, 3	Gravelly silty sand Brown Dry, very fine to fine sand, rounded gravels to [illegible] inch [illegible] [illegible] some [illegible] [illegible]					FS #1 0.0 to 5.0
	2, 2.5, 3, 3.5, 4, 4.5	1, 2, 2, 3, 7, 2, 4						
	5, 5.5, 6, 6.5	7, 4, 8	Clayey sand, Dry to moist, Brown, very fine to fine sand, clays [illegible] [illegible] plastic					FS #2 5.0 to 7.0
	7, 7.5, 8, 8.5, 9, 9.5	10, 5, [illegible], [illegible]	Slightly silty sand Brown moist, very fine to fine sand [illegible] gravel [illegible] sand					FS #3 7.0 to

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ENG FORM 1836-R [illegible] 1 APR 63

Local reproduction authorized 19 Jun 67

[illegible] Depot Armament/Ord. | [illegible] 2FB2-4[illegible]

Hole No. LF82-4L

DRILLING LOG	DIVISION: South Pacific	INSTALLATION: USAED Sacramento	SHEET 1 OF 1 SHEETS

1. PROJECT: Depot Armament/Ordnance	10. SIZE AND TYPE OF BIT: 7" Hollow Stem Auger
2. LOCATION (Coordinates or Station): Hill AFB	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY: Rollins, Brown, & Gunnell	12. MANUFACTURER'S DESIGNATION OF DRILL: CME #55 Std. Penetrometer
4. HOLE NO. (As shown on drawing title and file number): LF82-4L	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER: Tom Snow	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE — STARTED: Oct 27, 1982 — COMPLETED: Oct 27, 1982
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE: 6 ft	19. SIGNATURE OF INSPECTOR: [signature]

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS d	BOX OR SAMPLE NO. e	% RECOVERY f	H_2O g	Ov h	REMARKS i
	0.5	4	Gravely silty sand, Dark Brown, Damp, very fine to fine sand, Rounded gravels to 1½ inch, organic mat, Roots etc					
		5						
	1	8	Silty sand, Dark Brown, moist, very fine to fine sand					
	1.5	/						
	2	/						
		3						
	2.5	3						
	3	4	-Above					
	3.5	/						
	4	/	Silty sand, Brown, moist, very fine to fine sand, Angular sand					
	4.5	/						
	5	3						
	5.5	3						
	6	3	Bottom					

ENG FORM 1836-R 1 APR 63 PREVIOUS EDITIONS MAY BE USED (EM 1110-1-1801)
Local reproduction authorized 19 Jun 67

PROJECT: Depot Armament/Ordnance HOLE NO. LF82-42

DRILLING LOG	DIVISION: South Pacific	INSTALLATION: USAED Sacramento	SHEET 2 OF 2 SHEETS

1. PROJECT: Depot Armament/Ordnance
2. LOCATION (Coordinates or Station): Hill AFB
3. DRILLING AGENCY: Rollins, Brown & Gunnell
4. HOLE NO. (As shown on drawing title and file number): 2FB2-93
5. NAME OF DRILLER: Tom Snow
6. DIRECTION OF HOLE: [x] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 20 ft
10. SIZE AND TYPE OF BIT: 7" Hollow Stem Auger
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: CME #55 Std Penetrometer
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 7 | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED Oct 28, 1982 | COMPLETED Oct 29, 1982
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR: [signature]

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS	BOX OR SAMPLE NO.	% RECOVERY	H_2O	Dr	REMARKS
	10.5	6	Sand as above					
	11	9						
		11						
	11.5	/						
	12							
		7						
	12.5		Gravelly sand, gray to brown, damp, fine to medium sand, [illegible] gravel, gravels [illegible]					F-4 12.5 to [illegible]
	13	11						
	13.5	14						
	14	/	Slightly silty sand, gray-brown, damp, very fine to fine sand. Iron staining					F-5 [illegible] to 15
	14.5	7						
	15	8	Sand, silty clay, brown, moist, v.f. sand, med. plastic					F-6 15 to 15.2
		13	Slightly silty sand, gray-brown, damp, very fine to fine sand, some iron staining					F-7 15.2 to 20
	15.5	/						
	16							
		10						
	16.5	16						
	17	19						
	17.5	/						
	18	/						
	18.5	5						
	19	11						
	19.5	17						

ENG FORM 1836-R 1 APR 63 PREVIOUS EDITIONS MAY BE USED (EM 1110-1-1801)
Local reproduction authorized 29 Jun 67

PROJECT: Depot Armament/Ordnance | HOLE NO.: 2FB2-93

Hole No. 2F82-99

DRILLING LOG	DIVISION South Pacific	INSTALLATION USAED Sacramento	SHEET 1 of 2 SHEETS
1. PROJECT Depot Armament Ordnance		10. SIZE AND TYPE OF BIT 7" Hollow Stem Auger	
2. LOCATION (Coordinates or Station) Hill AFB		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
3. DRILLING AGENCY Rollins, Brown & Gunnell		12. MANUFACTURER'S DESIGNATION OF DRILL CME #55 Std. Penetrometer	
4. HOLE NO. (As shown on drawing title and file number) 2F82-99		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED / UNDISTURBED
5. NAME OF DRILLER Tom Snow		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
		16. DATE HOLE	STARTED Oct 29, 1982 / COMPLETED Oct 29, 1982
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE	
8. DEPTH DRILLED INTO ROCK		18. TOTAL CORE RECOVERY FOR BORING	%
9. TOTAL DEPTH OF HOLE 20 ft.		19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS d	BOX OR SAMPLE NO. e	% RECOVERY f	R_2O g	γ_d h	REMARKS i
	.5, 1	3, 5	Gravelly silty sand, brown, v.f. to fine sand, some organic mat, roots etc					
	1.5, 2, 2.5, 3	5, /, 3	Silty sand, dark brown, moist, very fine to fine, sub angular sand					
	3.5, 4, 4.5	3, /, 14	Silty sand, brown, damp, very fine to [illegible] sand					
	5, 5.5, 6, 6.5	6, /, /, 6	[illegible]					
	7, 7.5, 8	9, 10, /	Sandy clay, brown, damp, very fine sand, some silt seams, low plastic fines					
	8.5, 9, 9.5	8, 10, 11, /	Silty sand, brown, damp, very fine to fine sand, thin 0.1 layers of clean sand + sandy silt.					

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ENG FORM 1836-R 1 APR 63 PREVIOUS EDITIONS MAY BE USED (EM 1110-1-1801)
Local reproduction authorized 19 Jun 67

PROJECT Depot Arm / Ordnance HOLE NO. 2F82-9

Hole No. 2FB2-44

DRILLING LOG	DIVISION: South Pacific	INSTALLATION: USAED Sacramento	SHEET 2 OF 2 SHEETS
1. PROJECT: Depot Armament/Ordnance		10. SIZE AND TYPE OF BIT: 7" Hollow Stem Auger	
2. LOCATION: Hill AFB		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
3. DRILLING AGENCY: Rollins, Brown, & Gunnell		12. MANUFACTURER'S DESIGNATION OF DRILL: CME #55 Std. Penetration	
4. HOLE NO. (As shown on drawing title and file number): 2FB2-44		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN / DISTURBED / UNDISTURBED	
5. NAME OF DRILLER: Tom Snow		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE: [x] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
		16. DATE HOLE: STARTED Oct 29, 1982 / COMPLETED Oct 29, 1982	
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE	
8. DEPTH DRILLED INTO ROCK		18. TOTAL CORE RECOVERY FOR BORING %	
9. TOTAL DEPTH OF HOLE: 20 ft		19. SIGNATURE OF INSPECTOR: B. Hooper	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS d	BOX OR SAMPLE NO. e	% RECOVERY f	N_2O g	W_c h	REMARKS i
			Silty sand as above					
	10.5	7						
	11	10	Sand, Brown, Fine to Med Sub Angular grained, Moist					
	11.5	14						
	12		Gravelly Sand, Brown Moist, Fine to Coarse Sand Rounded Gravels to 3/4 inch					
	12.5	12						
		14						
	13							
	13.5							
	14	10	Slightly silty sand Brown Damp, very Fine to Med grained, scattered gravels to 1/2 inch					
	14.5							
	15	13						
		18						
	15.5							
	16		Gravely Sand Brown Moist Fine to Med Sand Rounded Gravels to 1/2"					
	16.5	12						
		19	Silty Sand, Brown Damp very Fine to Fine sand					
	17							
	17.5	20						
	18		Silty sand, gray Brown, Damp very Fine to Fine sand					
	18.5							
	19	15						
		21						
	19.5							
		27	BOH					

ENG FORM 1836-R 1 APR 62 PREVIOUS EDITIONS MAY BE USED (ER 1110-1-1801)
Local reproduction authorized 19 Jun 67

PROJECT: Depot Arm/Ordnance | HOLE NO. 2FB2-44

Hole No. 2F-82-45

DRILLING LOG	DIVISION: South Pacific	INSTALLATION: Austed Sacramento	SHEET 1 of 2 SHEETS

1. PROJECT: Depot Armor and weapons shop
2. LOCATION (Coordinates or Station): Hill AFB
3. DRILLING AGENCY: Rollins Brown + Gunnel
4. HOLE NO. (As shown on drawing title and file number): 2F 82-45
5. NAME OF DRILLER: Tom snow
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 20 Ft

10. SIZE AND TYPE OF BIT: 7" Hollow stem Auger
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: CME 55 + std penetrometer
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED Oct 29 1982 | COMPLETED Oct 29 1982
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR: [signature]

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS d	BOX OR SAMPLE NO. e	% RECOVERY f	H_2O g	Dr h	REMARKS i
	0.5	6 / 8	Gravelly silty Sand moist, very fine to fine sand, organic mat roots etc. Cobbles gravels to 1 inch					
	1 / 1.5	11 / 7	Gravelly silty sand, Brown damp, fine sand, gravels to 1 inch					
	2 / 2.5 / 3 / 3.5 / 4	5 / 5 / 7 / 7 / 4	Silty Sand, Brown very fine to fine sand, moist low to fines					
	5 / 5.5 / 6	6 / 7 / 7	Slightly silty dirty sand, Brown moist fine sub angular grained					
	6.5 / 7 / 7.5 / 8	5 / 7 / 9 / 7 / 9	As above with thin layers of silty sand					
	8.5 / 9 / 9.5 / 10	12 / 13 / 7	Gravelly Sand, Brown moist. Fine to coarse sand, Rounded gravels to 1 inch					

ENG FORM 1836-R 1 APR 63 PREVIOUS EDITIONS MAY BE USED (EM 1110-1-1801)

Local reproduction authorized 19 Jun 67

PROJECT: Depot Armament shop Hill AFB | HOLE NO. 2F 82-45

DRILLING LOG	DIVISION SY	INSTALLATION SECTO
1. PROJECT Dispos[illegible] Sym/Ammo WEAPONS Shop		10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station) Hill AFB		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY		12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number) 2 F-32-HS		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN
5. NAME OF DRILLER		14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ___ DEG. FROM VERT.		15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN		16. DATE HOLE STARTED Oct 29 1982 COMPLETED Oc[illegible]
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE 20 FT		18. TOTAL CORE RECOVERY FOR BORING
		19. SIGNATURE OF INSPECTOR [illegible]

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS d	BOX OR SAMPLE NO. e	% RECOVERY f	H_2O g	Dr h	REMARKS
	10.5 – 12.5	7 / 11 / 13	Slightly silty sand Brown, very fine to fine sand, scattered gravels [illegible] 1/2 inch					
	12.5 – 14	[illegible]	Gravelly sand Brown [illegible] fine to med [illegible] sub angular grained [illegible] %					
	14 – 16.5	9 / 11 / 12 / 10	Silty sand, Brown Damp very fine to fine sand, some Iron staining					
	16.5 – 19	14 / 27	Silty sand, light Brown, very fine sand some Iron staining, one Th[illegible] layer of clay					
	19 – 20	17 / [illegible]	Sand, Brown Damp fine to med sub angular grained					
	20		BOH					

ENG FORM 1836-R 1 APR 63 PREVIOUS EDITIONS MAY BE USED (EM 1110-1-1801)

Local reproduction authorized 19 Jun 67

PROJECT Disp[illegible] Sym/Ammo Weapons Shop, Hill AFB

DRILLING LOG	DIVISION South Pacific	INSTALLATION USAED Sacramento	SHEET 1 OF 1 SHEETS

1. PROJECT: Depot Armament/Ordnance
2. LOCATION (Coordinates or Station): Hill AFB
3. DRILLING AGENCY: Rollins, Brown & Gunnell
4. HOLE NO. (As shown on drawing title and file number): 2F82-46
5. NAME OF DRILLER: Tom Snow
6. DIRECTION OF HOLE: ☑ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 6 ft
10. SIZE AND TYPE OF BIT: 7" Hollow Stem Auger
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: CME #55 Std. Penetrometer
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED Oct 27, 1982 | COMPLETED Oct 27, 1982
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR: [illegible signature]

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS d	BOX OR SAMPLE NO. e	% RECOVERY f	H_2O g	W h	REMARKS i
	0 – 0.5	2	Slightly silty sand, light brown, damp, fine sand, organics, roots, etc.					
	0.5 – 4	3, 5, 7, 5, 6, ·, 1	Silty sand, brown, damp, very fine to fine sand, low % fines					
	4 – 5.5	1, 4, 7	Silty sand, brown, damp, very fine to fine sand, [illegible] fines					
	5.5 – 6	8	Sandy clay, light brown, damp, w/ very fine sand and [illegible] plastic					EOH

ENG FORM 1836-R 1 APR 63 PREVIOUS EDITIONS MAY BE USED (EM 1110-1-1801)
Local reproduction authorized 19 Jan 67

PROJECT | HOLE NO.

DRILLING LOG | DIVISION: South Pacific | INSTALLATION: USAED Sacramento | SHEET 1 of 2 SHEETS

1. PROJECT: Depot Armament / Ordnance
10. SIZE AND TYPE OF BIT: 7" Hollow Stem Auger
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
2. LOCATION (Coordinates or Station): Hill AFB
3. DRILLING AGENCY: Rollins, Brown & Gunnell
12. MANUFACTURER'S DESIGNATION OF DRILL: CME 55 Std. Penetrometer
4. HOLE NO. (As shown on drawing title and file number): 2F82-97
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED
5. NAME OF DRILLER: Tom Snow
14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED 27 Oct. 82 | COMPLETED 27 Oct. 82
7. THICKNESS OF OVERBURDEN
17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK
18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE: 20 ft
19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS d	BOX OR SAMPLE NO. e	% RECOVERY f	H_2O g	Dd h	REMARKS i
	0.5	4	Gravely silty sand D. Brown Damp very fine to fine sand Gravels to 2 inch approximat	Roots etc				
	1 – 1.5	5 / 4	Silty sand, Brown Damp very fine to fine sand. Some organic mat roots etc					
	2 – 5	2 / 2 / 3	As above					
	5.5 – 6.5	3 / 5	Clayey sand mottled Tan + Brown, very fine sand clay ...					
	7 – 7.5	6 / 11	Silty sand, Brown Damp very fine sand					
	8 – 8.5	6	Sandy silt light Brown Damp, very fine sand					
	9 – 9.5	9 / 12	Slightly silty sand, S... Brown very fine to fine SubAngular sand some iron stains mostly sand					

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ENG FORM 1836-R 1 APR 63 PREVIOUS EDITIONS MAY BE USED. (ER 1110-1-1801) | PROJECT: Depot Arm./Ordnance | HOLE NO. 2F82-97
Local reproduction authorized 15 Jun 67

Hole No. 2FB2-97

DRILLING LOG	DIVISION South Pacific	INSTALLATION USAED Sacramento	SHEET 2 OF 2 SHEETS

1. PROJECT Depot Armament / Ordnance
2. LOCATION (Coordinates or Station) Hill AFB
3. DRILLING AGENCY Rollins, Brown & Gunnell
4. HOLE NO. (As shown on drawing title and file number) 2FB2-97
5. NAME OF DRILLER Tom Snow
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE 20 ft
10. SIZE AND TYPE OF BIT 7" Hollow Stem Auger
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL CME #55 Std. Penetrometer
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE | STARTED [illegible] | COMPLETED [illegible]
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR [signature]

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS d	BOX OR SAMPLE NO. e	% RECOVERY f	H_2O g	Wc h	REMARKS i
			AS ABOVE					
	10.5	5						
	11	8	Sand, Brown Damp, Fine to med [illegible]					
	11.5	14 /						
	12		Silty Sand, [illegible]					
	12.5		Gravelly Sand, Brown Damp, Fine to med Sub-Angular Sand [illegible] Gravels to 3/4 inch					
	13	4						
	13.5	24 /						
	14							
	14.5	5						
	15	10						
	15.5	13 /						
	16	4	Sand, Clay, Brown Moist Very Fine Sand, Low Plastic Clay					
	16.5		Slightly Silty Sand Brown Damp, Fine Sand, Low to Fines					
	17	11						
	17.5	18 /						
	18							
	18.5							
	19	10	Sand as ABOVE					
	19.5	16						
			BOH					

ENG FORM 1836-R 1 APR 63 PREVIOUS EDITIONS MAY BE USED (ER 1110-1-1801) | PROJECT Depot Armament/Ordnance | HOLE NO. 2FB2-97

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DRILLING LOG | DIVISION: South Pacific | INSTALLATION: USAED Sacramento | SHEET 1 OF 1 SHEETS

1. PROJECT: Depot Armament / Ordnance

2. LOCATION: Hill AFB

3. DRILLING AGENCY: Rollins, Brown, & Gunnell

4. HOLE NO.: 2FB2-4B

5. NAME OF DRILLER: Tom Snow

6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.

7. THICKNESS OF OVERBURDEN

8. DEPTH DRILLED INTO ROCK

9. TOTAL DEPTH OF HOLE: 20ft

10. SIZE AND TYPE OF BIT: 7" Hollow Stem Auger

11. DATUM FOR ELEVATION SHOWN (TBM or MSL)

12. MANUFACTURER'S DESIGNATION OF DRILL: CME #55 Std. Penetrometer

13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED

14. TOTAL NUMBER CORE BOXES

15. ELEVATION GROUND WATER

16. DATE HOLE: STARTED OCT 27, 1982 | COMPLETED OCT 27, 1982

17. ELEVATION TOP OF HOLE

18. TOTAL CORE RECOVERY FOR BORING %

19. SIGNATURE OF INSPECTOR: B. [signature]

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS	BOX OR SAMPLE NO.	% RECOVERY	H_2O	γ_d	REMARKS
	0.5	4	ORGANIC SILTY SAND & GRAVELS TO 2 inch ROOTS ETC					
	1	13	Silty Sand, Brown, Damp to moist, very fine to fine sand					
	1.5	12						
	2	/						
	2.5	5						
	3	4	Silty sand AS ABOVE					
	3.5	4						
	4	/						
	4.5	3						
	5	4	AS ABOVE					
	5.5	4						
	6	/						
	6.5	3						
	7	3						
	7.5	5						
	8	/						
	8.5	5	SAME AS ABOVE					
	9	5						
	9.5	7	Slightly silty sand Light Brown moist very fine to fine sand					

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ENG FORM 1836-R 1 APR 63 PREVIOUS EDITIONS MAY BE USED (EM 1110-1-1801)
Local reproduction authorized 19 Jun 67

PROJECT: Depot Army/Ordnance | HOLE NO.: 2FB2-4B

Hole No. 2F82-4B

DRILLING LOG	DIVISION South Pacific	INSTALLATION USAED Sacramento	SHEET 2 of 2 SHEETS
1. PROJECT Depot Armament/Ordnance		10. SIZE AND TYPE OF BIT 7" Hollow Stem Auger	
2. LOCATION (Coordinates or Station) Hill AFB		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
3. DRILLING AGENCY Rollins, Brown, & Gunnell		12. MANUFACTURER'S DESIGNATION OF DRILL CME #55 Std Penetrometer	
4. HOLE NO. (As shown on drawing title and file number) 2F82-4B		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN / DISTURBED / UNDISTURBED	
5. NAME OF DRILLER Tom Snow		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ___ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN		16. DATE HOLE STARTED Oct 27, 1982 COMPLETED Oct 27, 1982	
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE	
9. TOTAL DEPTH OF HOLE 20 ft		18. TOTAL CORE RECOVERY FOR BORING %	
		19. SIGNATURE OF INSPECTOR [signature]	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS d	BOX OR SAMPLE NO. e	% RECOVERY f	H_2O g	Wn h	REMARKS i
	10.5	8						
	11 – 12	10, 12	Gravelly sand Clean, Gray Brown Fine to med sand Angular grained Rounded gravels to 3/4 in					
	12 – 14	7, 12, 13	Slightly silty (Dirty) sand, Damp, Brown ... Subangular sand Iron staining					
	14 – 18	11, 13, 14, 3, 10, 16	Sand, Gray Brown Damp, Fine to med Sand, some Iron Staining As above					
	18 – 20	11, 16, 22	Silty sand, Light Brown, very fine to fine sand 40% Fines BOH					

ENG FORM 1 APR 63 1836-R PREVIOUS EDITIONS MAY BE USED (EM 1110-1-1801)

Local reproduction authorized 19 Jan 67

PROJECT Dept Arms/Ordnance | HOLE NO. 2F82-4B

DRILLING LOG | DIVISION: South Pacific | INSTALLATION: USAED Sacramento

1. PROJECT: Depot Armament/Ordinance
2. LOCATION (Coordinates or Station): Hill AFB
3. DRILLING AGENCY: Rollins, Brown, & Gunnell
4. HOLE NO. (As shown on drawing title and file number): 2FB2-49
5. NAME OF DRILLER: Tom Snow
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 20 ft

10. SIZE AND TYPE OF BIT: 7" Hollow...
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: CME #55 Std.
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED 02-27-1982
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING
19. SIGNATURE OF INSPECTOR: [signature]

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS	BOX OR SAMPLE NO.	% RECOVERY	H_2O	Wx	REMARKS
	0.5–1.5 (blows 10, 10, 7)		Gravelly Silty Sand, Brown Damp, Very Fine To Fine Sand, Rounded gravels To 2½ inch					FSH 0–T... note...
	1.5–4 (blows 1, 5, 5, 1)		Silty Sand, Brown Damp, Very Fine To Fine [illegible] Angular [illegible]					FST 1.5...
	4–6.5 (blows 4, 4, 4)		Silty Sand, Brown Fine [illegible] Fine [illegible]					[illegible]
	6.5–9 (blows 7, 9, 7)		[illegible] Sand, Brown, Fine [illegible] [illegible]					FSH 6.5
	9–10 (blows 14)		Gravelly Sand, Brown Damp, Clean, Fine To Med Sub Angular Sand, Rounded gravels To 3½ inch.					FSH 9.5

ENG FORM 1836-R 1 APR 65 PREVIOUS EDITIONS MAY BE USED (EM 1110-1-1801)

Local reproduction authorized 19 Jan 67

PROJECT: Depot Armament/O...

DRILLING LOG	DIVISION South Pacific	INSTALLATION USAED Sacramento	SHEET 2 OF 2 SHEETS

1. PROJECT: Depot Armament/Ordnance
2. LOCATION (Coordinates or Station): Hill AFB
3. DRILLING AGENCY: Rollins, Brown & Gunnell
4. HOLE NO. (As shown on drawing title and file number): 2FB2-99
5. NAME OF DRILLER: Tom Snow
6. DIRECTION OF HOLE: [x] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 20 ft
10. SIZE AND TYPE OF BIT: 7" Hollow Stem Auger
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: CME #55 Std. Penetrometer
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 8 | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED Oct 27, 1982 | COMPLETED Oct 27, 1982
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR: B. Gaspar

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS	BOX OR SAMPLE NO.	% RECOVERY	H_2O	Wt	REMARKS
	10.5 – 11	7, 11	Sand as above less gravels -					
	11 – 13.5	13, 4, 9, 15	Slightly silty sand light brown, damp, very fine to fine (and medium) sand					FS #6 11.0 to 13.5
	13.5 – 16	16, 1, 2	Sand clean tan damp, fine to med. [illegible] grained [illegible] gravels to 3/4 inch					FS #7 13.5 to 15.0
	16 – 18	10, 14, 20	Sand as above some heavy iron stained layers -					
	18 – 20	12, 22, 30	Silty sand, brown damp, very fine to fine sand, low % fines.					FS #8 18.0 to 20.0
			BOH					

ENG FORM 1836-R 1 APR 63 PREVIOUS EDITIONS MAY BE USED (EM 1110-1-1801)

Local reproduction authorized 19 Jun 67

PROJECT: Depot Arm/Ordnance | HOLE NO. 2FB2-99

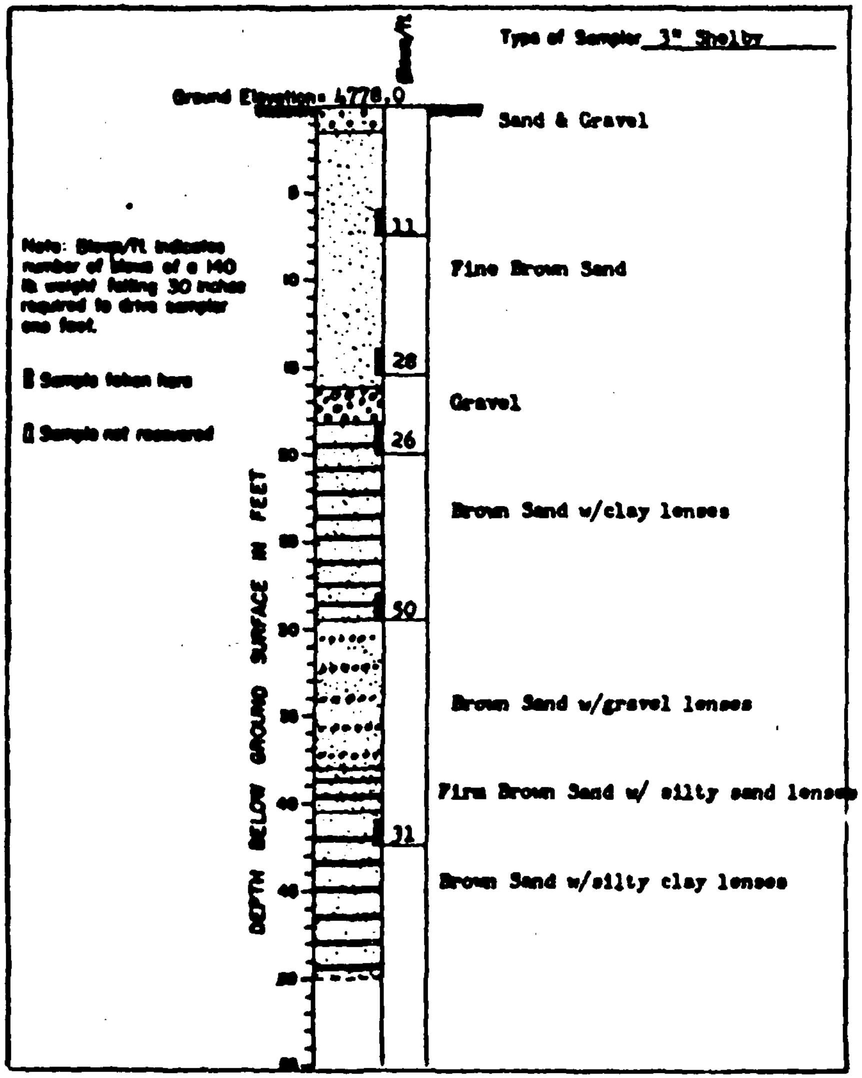

EXHIBIT "E"

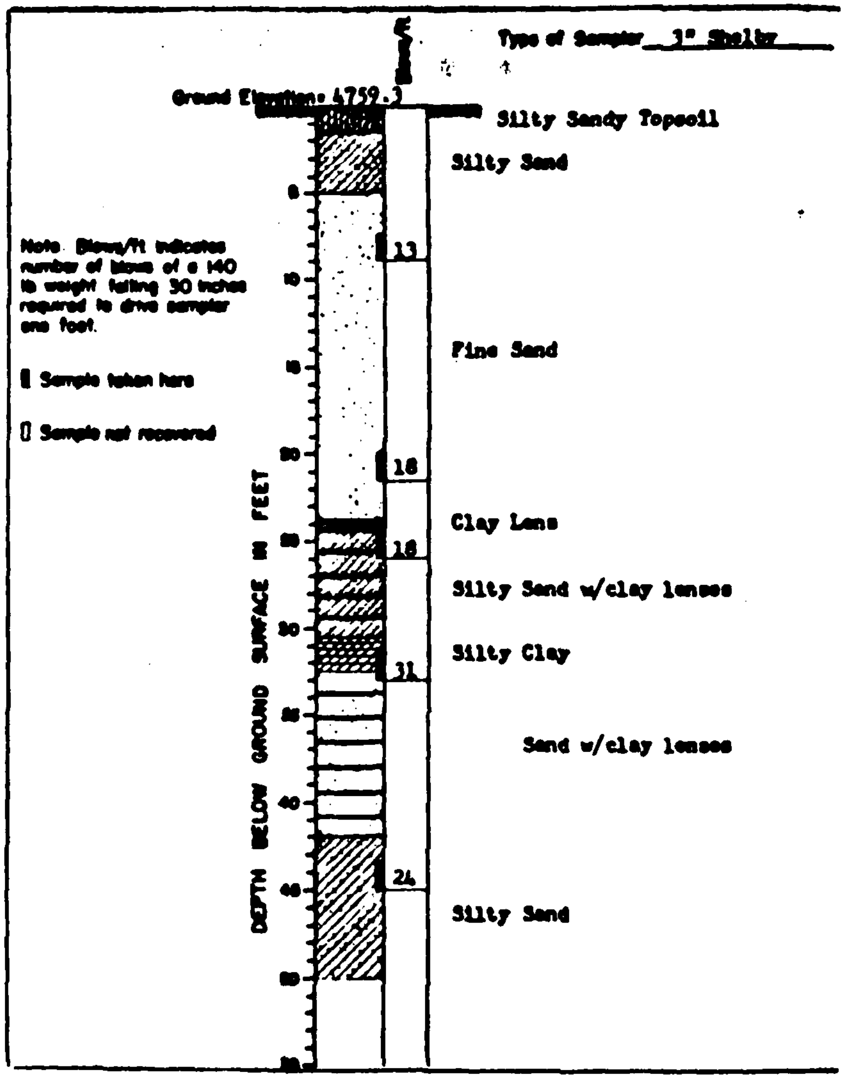

EXHIBIT "F"

Type of Sampler 3" Shelby

Type of Sampler 3" Shelby

DR-8

DAILY REPORT

Petersen Bros. Drilling Co., Inc.

WELL DRILLING • ELEVATOR JACKHOLES

1775 NORTH BECK STREET
SALT LAKE CITY, UTAH 84116
PHONE (801) 532-1222

Wed — Jan — 2 — 1980
DAY OF WEEK — MONTH — DAY — YEAR

Job Hill Air Force Base

Job Number HIL 197-0

F 42650-80-C-3509

80-1 Drilled Hole No 1 38' Deep Set 4" Pipe 33' Deep.

0-12' Sand + Gravel
12-22 Clay + Sand
22-38' Clay No Water

80-2 Drilled Hole No 2 36' Deep Set 31' of 4" Pipe

0-20 Sand + Gravel
20-28 Clay + Sand
28-36 Clay

EMPLOYEE	START a.m.	START p.m.	REMARKS	FINISH a.m.	FINISH p.m.	TOTAL HOURS
Odell Burns						8.0
Dan Hill						8.0
Dave Deford						8.0

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DAILY REPORT

Petersen Bros. Drilling Co., Inc.

WELL DRILLING • ELEVATOR JACKHOLES

1775 NORTH BECK STREET
SALT LAKE CITY, UTAH 84116
PHONE (801) 532-1222

DAY OF WEEK	MONTH	DAY	YEAR
Friday	Jan	4	1980

Job Hill Air Force Base

Job Number HIL 197-0

F42650-80-C-3509

EO-3 Drilled Hole No 3 39' Deep Set
34' of 4" P.V.C casing

0 - 28' Loose Gravel + Sand
28 - 32 Tight " "
32 - 39 Clay

EMPLOYEE	START am	START pm	REMARKS	FINISH am	FINISH pm	TOTAL HOURS
Odell B						8
Dan H						8
Dave Deford						8

DAILY REPORT

Petersen Bros. Drilling Co., Inc.

WELL DRILLING ● ELEVATOR JACKHOLES

1775 NORTH BECK STREET
SALT LAKE CITY, UTAH 84116
PHONE (801) 532-1222

Thursday + Friday — DAY OF WEEK | Jan — MONTH | 10th + 11th — DAY | 1980 — YEAR

Job: Hill Air Force Base

Job Number: ~~HTE 42650~~ HIL 197-0

F. 42650-80-C3509

80-7 Drilled Hole No 7 To a depth of 42'
installed 36' of P.V.C. Pipe.

Hole 7 - 0 - 12 Tight clay + Gravel
12 - 31 Loose Gravel
31 - 37 Tight Gravel + cobbles
37 - 42 clay

80-8 Drill Hole No 8 To 41' set P.V.C To 37'

0 - 10 Tight Sand
10 - 18 Sand + Gravel Garbage
18 - 36 Gravel + cobbles
36 - 41 clay

EMPLOYEE	START a.m.	START p.m.	REMARKS	FINISH a.m.	FINISH p.m.	TOTAL HOURS
ODell B						
Dan H						6.5
Duane D						6.5

DAILY REPORT

Petersen Bros. Drilling Co., Inc.

WELL DRILLING ● ELEVATOR JACKHOLES

1775 NORTH BECK STREET
SALT LAKE CITY, UTAH 84116
PHONE (801) 532-1222

Monday	Jan	14	1980
DAY OF WEEK	MONTH	DAY	YEAR

Job Hill Air Force Base

Job Number HIL 197-0

F 42650-80-C 3509

BC-9 Drilled Hole No 9 To a depth of 41'

Set P.V.C To 33'

0-4 Sandy clay
4-25 Garbage Dump - Paper - cable - Trash
25-31 Gravel + Sand
31-41 clay

EMPLOYEE	START am	START pm	REMARKS	FINISH am	FINISH pm	TOTAL HOURS
O'Dell B						
Dan H						8
Dave D						8

DAILY REPORT

Petersen Bros. Drilling Co., Inc.

WELL DRILLING • ELEVATOR JACKHOLES

1775 NORTH BECK STREET
SALT LAKE CITY, UTAH 84116
PHONE (801) 532-1222

DAY OF WEEK	MONTH	DAY	YEAR
Tuesday	Jan	15	1980

Job Hill Air Force Base

Job Number HIL 197-0
F 42650-80-C3507

80-10 Drill Hole No 10 To a depth of 40'
set 33' of P.V.C. Pipe

0-11 Hard Tight sand + Gravel
11-27 Loose Gravel + cobbles
27-31 Tight Gravel
31-40 Clay

80-11 Drill Hole # 11 To a depth of 40' set 33'
P.V.C 4" Pipe

0-11 Hard tight Sand + Gravel
11-22 Gravel + Garbage
22-30 Sand + Gravel
30-40 Clay

EMPLOYEE	START am	START pm	REMARKS	FINISH am	FINISH pm	TOTAL HOURS
Don H.						6
Dave D						6

Heavy Rain

DAILY REPORT

Petersen Bros. Drilling Co., Inc.

WELL DRILLING • ELEVATOR JACKHOLES

1775 NORTH BECK STREET
SALT LAKE CITY, UTAH 84116
PHONE (801) 532-1222

DAY OF WEEK	MONTH	DAY	YEAR
Wednsday	Jan	16	1980

Job Hill Air Force base

Job Number HIL 197-0
F42650-80-C-3507

Drill Hole #12 To a depth of 40'
Set P.V.C To 35'

Drilled 10' + started over because of Bolder + Caving Problems.

0-16 sand + clay Gravel
16-34 sand Gravel + cobbles. loose
34-40 clay

EMPLOYEE	START am	START pm	REMARKS	FINISH am	FINISH pm	TOTAL HOURS
Dan H.						8
Dave D						8

DAILY REPORT

Petersen Bros. Drilling Co., Inc.

WELL DRILLING ● ELEVATOR JACKHOLES

1775 NORTH BECK STREET
SALT LAKE CITY, UTAH 84116
PHONE (801) 532-1222

Thursday — Jan — 13 — 1980
DAY OF WEEK — MONTH — DAY — YEAR

Job Hill Air Force Base
Job Number HIL-157-0
F42650-80-C3509

80-13 Drilled Hole #13 To 41' Set casing 36
0-6 clay + Gravel
6-25 Gravel, cobbles + Sand Water
25-41 clay

80- Drilled Hole #14 TO 41' Depth
Set 30' 4" P.V.C

0-6 clay + Gravel
6-31 Gravel, cobbles + Sand. Water
31-41 Clay

EMPLOYEE	START am	START pm	REMARKS	FINISH am	FINISH pm	TOTAL HOURS
Dan H						8
Dave D						8

DAILY REPORT

Petersen Bros. Drilling Co., Inc.

WELL DRILLING ● ELEVATOR JACKHOLES

1775 NORTH BECK STREET
SALT LAKE CITY, UTAH 84116
PHONE (801) 532-1222

DAY OF WEEK	MONTH	DAY	YEAR
Friday	Jan	18	1980

Job Hill Air Force Base

Job Number HIL 197-0
F41650-80-C-3509

BT-15 Drilled Hole No #15 Total Depth 39
Set P.V.C. 36'
0-18 clay Gravel + Sand
18-25 Gravel with Water
25-33 Sand + Gravel
33-39 Clay

BT-16 Drilled Hole No 16 Total Depth 39
Set P.V.C 36'
0-6 clay sand + Gravel
6-18 Sand + loose Gravel
18-35 Gravel + Cobbles
35-40 clay

EMPLOYEE	START am	START pm	REMARKS	FINISH am	FINISH pm	TOTAL HOURS
Dan H						8
Dave D.						8

DAILY REPORT

Petersen Bros. Drilling Co., Inc.

WELL DRILLING ● ELEVATOR JACKHOLES

1775 NORTH BECK STREET
SALT LAKE CITY, UTAH 84116
PHONE (801) 532-1222

Monday	Jan	21	1980
DAY OF WEEK	MONTH	DAY	YEAR

Job Hill Air force base

Job Number HIL 197-0

F 42650-80-C3509

8-17 Drilled Hole No 17 Had problems
+ redrilled 3-times. Total Depth 37'
set 32' P.V.C Pipe

0-4 Firm Sand
4-25 Sand with small Gravel
25-30 Sand + Gravel
30-40 Clay

EMPLOYEE	START a.m.	START p.m.	REMARKS	FINISH a.m.	FINISH p.m.	TOTAL HOURS
Don						8
Dune						8

DAILY REPORT

Petersen Bros. Drilling Co., Inc.

WELL DRILLING • ELEVATOR JACKHOLES

1775 NORTH BECK STREET
SALT LAKE CITY, UTAH 84116
PHONE (801) 532-1222

Tuesday	Jan	22	1980
DAY OF WEEK	MONTH	DAY	YEAR

Job Hill Air Force Base

Job Number HIL 197-0

F42650-80-C3509

Drilled Hole No 18 To 40' set P.V.C to 35'

0-3 Gravel
3-15 Clay
15-30 Gravel + Sand
30-40 clay

Drilled Hole No 19 to 32' set Pipe @ 36'

0-16 Gravel
16-25 Gravel sand + cobbles Water
25-31 Gravel + sand
31-40 clay

EMPLOYEE	START a.m.	START p.m.	REMARKS	FINISH a.m.	FINISH p.m.	TOTAL HOURS
Dan						8
Dave						8
Odell						

DAILY REPORT

Petersen Bros. Drilling Co., Inc.

WELL DRILLING ● ELEVATOR JACKHOLES

1775 NORTH BECK STREET
SALT LAKE CITY, UTAH 84116
PHONE (801) 532-1222

Wednesday (DAY OF WEEK) Jan (MONTH) 23 (DAY) 1980 (YEAR)

Job: Hill Air force base

Job Number: HIL 197-0
F 42650-80-C 3509

80-20 Drilled Hole No 20 to 40'
set Pipe to 35'
0-18 sand + Gravel
18-30 Gravel + Cobbles
30-40 Clay

80-21 Drilled Hole 21 to 40' set PVC
to 33
0-19 clay
19-27 sand + Clay
27-36 Clay — Water @ 27'
36-40 Hard Clay

EMPLOYEE	START am	START pm	REMARKS	FINISH am	FINISH pm	TOTAL HOURS

DAILY REPORT

Petersen Bros. Drilling Co., Inc.

WELL DRILLING ● ELEVATOR JACKHOLES

1775 NORTH BECK STREET
SALT LAKE CITY, UTAH 84116
PHONE (801) 532-1222

Thursday DAY OF WEEK Jan MONTH 24 DAY 1980 YEAR

Job Hill Air Force Base

Job Number HIL 1970
F 42650-80-C-3509

Drilled Hole No 22 TO 40' Set
P.V.C to 34'
0-6 clay + Gravel
6-26 Gravel + cobbles Loose
26-31 Gravel + Sand Water
31-40 Clay

EMPLOYEE	START am	START pm	REMARKS	FINISH am	FINISH pm	TOTAL HOURS
Dan H						8
Dave D						8

DAILY REPORT

Petersen Bros. Drilling Co., Inc.

WELL DRILLING ● ELEVATOR JACKHOLES

1775 NORTH BECK STREET
SALT LAKE CITY, UTAH 84116
PHONE (801) 532-1222

DAY OF WEEK	MONTH	DAY	YEAR
Thurs.	Jan	3	1980

Job Hill Air Force Base.

Job Number HIL 197-0 F 42650-80-C3507

80-23 Drilled Hole No 23

Drilled To 25' stuck tools left hole + Returned and Drilled TO Finished Depth of 42' casing installed TO 37'

0-22 Sand Gravel
22-25 cemented Large cobbles.
25-36 Sand + Gravel
36-42 Clay

EMPLOYEE	START am	START pm	REMARKS	FINISH am	FINISH pm	TOTAL HOURS
Odell B						6.0
Dan Hill						6.0
Dave D.						6.0

DAILY REPORT

Petersen Bros. Drilling Co., Inc.

WELL DRILLING ● ELEVATOR JACKHOLES

1775 NORTH BECK STREET
SALT LAKE CITY, UTAH 84116
PHONE (801) 532-1222

DAY OF WEEK	MONTH	DAY	YEAR
Friday	Jan	25	1980

Job Hill Air Force base

Job Number HIL 197-0

F 42650-80-C3509

80-24 Drilled Hole No 24 To 38' set P.V.C. To 34'

0-30 Garbage - Hard To drill
30-33 Some Clay + Garbage
33-38 Clay

80-25 Drilled Hole No 25 To 43' set P.V.C To 38'

0-24 Sand + Gravel
24-34 Gravel + Cobbles - Water 32'
34-37 Gravel + Clay Hard
37-43 Clay

EMPLOYEE	START am	START pm	REMARKS	FINISH am	FINISH pm	TOTAL HOURS
Dan H.						6.5
Dave D						6.5

Moved From Location ~~Monday~~ Tuesday Jan 29th 1980

Odell Burns

Peterson Brothers

"80' Series Wells

Casing Depths

very little water in drilling

DF-9

Hole	Depth of PVC pipe	
1	33'	mostly clay after 5 feet
2	31'	
3	34'	
4	33'	
5	31'	
6	38'	
7	36'	
8	37'	
9	33'	
10	33'	
11	33'	
12	35'	
13	36'	
14	36'	loose sandy clay
15	36'	got into hard clay
16	36'	
17	32'	
18	35'	Clay heavy all the way down
19	36'	Most water
20	35'	
21	33'	sandly clay on top clay to the bottom
22	34'	
23	37'	
24	34'	
25	38'	
	865	

in bottom is very tough clay all is sandy clay

W#1

(Geologic logs)

0-3 fill

3-6 Fine sand gravel at 4½'

6-9 Sand gravel gravel at 7'

9-12 gravel

12-15 gravel

15-18 gravel

18-21 gravel

21-24 sand gravel [illegible] at 23' — RAISED TO 10'

24-27 " "

27-30 " "

30-33 " " clay at 32'

33-35 + clay

PREVIOUS PAGE IS BLANK

W # 2

0-3 Soil

3-6 Sandy Soil · Foam

6-9 " " Gravel at 9'

9-12 Gravel

12-15 "

15-18 "

18-21 ~~clay~~ SILT

21-24 sandy ~~clay~~ SILT · Rose to 19

24-27 ~~clay~~ SILT & ~~FEET~~

27-30 + SILT · WATER AT 28' SATURATED SAND & SILT

30-33 + SILT

~~33~~-35 SILT

35-38 SILTY CLAY

38-41 GRAVEL

41-45 CLAY

Foam [illegible] · WATER AT 41 UNDER PRESSURE. ROSE TO 27'

W #3

0-3 Sandy soil

3-6 " "

6-9 sand gravel 7 am

9-12 gravel

12-15 gravel

15-18 gravel

18-21 gravel

21-24 "

24-27 silt

27-30 silt gravel some clay Water

30-33 clay

33-35 clay.

A' DOWN

W # H.

0-3 soil + sand
3-6 sand gravel
6-9 gravel 7 oam
9-12 gravel
12-15 "
15-18 "
18-21 "
21-24 "
24-27 sand 7 24'
27-30 "
30-33 " water at 30 (stinky looks like oil in water
33-35 clay
35-37 "

W # 5

0-3 clay
3-5 clay
5-6 gravel
6-7 gravel
7-9 sand
9-12 gravel Foam
12-15 ..
15-18 ..
18-21 .. possible clay at 21
~~3-1~~ 21-24 gravel WATER 23'
24-27 gravel
27-30 gravel
30-33 gravel
33-35 clay

No Water

W # 6
0-3 soil
3-6 sand
6-9 sand
9-10 sand
10-12 gravel
12-15 gravel
15-18 "
18-21 "
21-24 sand & gravel
24-27 gravel
27-30 sand
30-33 sand & gravel
33-35 clay
-40 CLAY
42 CLAY

FOAM

WATER 24'

W =7

0-3	SOIL	
3-6	SAND	
6 8	SAND	
8-9	GRAVEL	
9-11	SAND & GRAVEL	11-12
~~11-12~~	~~GRAVEL~~	
12-15	GRAVEL	DKT
15-18	"	
18-20	"	
20-21	SAND	WATER TO 21
21-24	CLAY	COULD BE WET

NO WATER

W#8

0-3	Soil Gravel	
3-6	gravel	
6-9	gravel sand	
9-12	Sand	
12-15	"	
15-18	sand gravel	Foam
18-21	Sand gravel	"
21-24	" "	"
24-27	" "	"
27-30	Gravel	"
30-33	"	"
33-35	clay	"

WATER TO 21

no water

W # 9

0-3	Gravel	a little water 3'
3-6	Gravel	Water 5'
6-9	"	
9-12	"	
12-15	"	
15-18	Sand gravel	
18-21	" "	Clay 19-21

W # 10

0-3 soil

3-6 sand

6-9 sand 7 Gam

9-12 gravel + sand

12-15 "

15-18 "

18-21 " WATER TO 21'

21-24 "

24-27 " SAMPLED + TRACK OF WATER

27-30 gravel + clay

30-33 clay

33-35 clay

W # 11

0-3 soil

3-6 silt

7 am

6-9 silt gravel at 7'

9-12 gravel

12-15 "

15-18 "

WATER TO 16'

18-21 "

21-24 "

24-27 sand

27-30 "

Water at 29' not to much

30-33 "

Water at 33

33-35 gravel

~~gravel~~ 35

35-38 Clay

38-41 Clay

W# 12

0-3 Sand

3-6 "

6-9 gravel   7 am

9-12 "

12-15 "

15-18 "

18-21 Silt — clay? at 21

21-24 clay

24-27 clay

27-30 clay   No water

WATER TO (15')

W-13

TEST HOLE A (13) ELEVATION 4810.

0-3	BROWN SANDY SILT
3-6	" " "
6-9	LIGHT BROWN CLAY
9-12	" " SILT
12	WATER
12-15	SAND & GRAVEL
15-18	" "
18-20	SAND
20-31	SAND
31-58	CLAY

W-14

TEST HOLE B (14) ELEVATION 4790

0-2	SAND & GRAVEL FILL
2-4	SILT & CLAY
4	WATER
4-6	SAND & SILT
6-9	" "
9-12	" "
12-15	" "
15-18	" "
18-20	" "
20-21	HARD SAND
21-24	HARD SILT
24-27	SILTY SAND
29-30	RED BROWN CLAY
30-33	SILTY CLAY
33-50	CLAY

50	SAND

APPENDIX D: FIELD DATA SUMMARIES

o Summary Logs of Daily Activities
(Includes Drilling Activities)

(pp. D-1 through D-117)

D-1

APPENDIX D: FIELD DATA SUMMARIES

o Summary Logs of Daily Activities
(Includes Drilling Activities)

(pp. D-1 through D-116)

D 2

RADIAN CORPORATION

Sheet 1 of 1

Log of Daily Activities

Date 18 October 1982 (Monday)   Log Recorded By R. Belan
Project Hill AFB, IRP Phase II   Corresponding Tape # N/A
Location Salt Lake City, UT
Personnel on Site Rick Belan (Radian), Robert Vandervort (Radian)

Time (Military)	Activity or Event
~0700	Depart Austin, Texas with field gear for temporary assignment to the Radian Salt Lake City, Utah office for conducting the Hill Air Force Base IRP Phase II field investigation.
0815	Begin conducting review of information received from Hill AFB and UBTL.
~1130	Arrived Salt Lake City, pick up a field car and proceed to Radian office.
~1200	Arrived at Radian office and met with Robert Vandervort (Program Manager) to discuss the Hill AFB project, weeks activities, safety program and support activities.
~1520	Conducted coordination calls with UBTL, ESC, and Hill AFB to notify of field plans and current activities.
1630	Resume data analysis.
1830	End of day's activities.

RADIAN CORPORATION

Sheet 1 of 1

Log of Daily Activities

Date 19 October 1982 (Tuesday)
Log Recorded By R. Belan
Project Hill AFB, IRP Phase II
Corresponding Tape # N/A
Location Salt Lake City, UT
Personnel on Site Rick Belan (Radian), Robert Vandervort (Radian)

Time (Military)	Activity or Event
0730	Begin data review and analysis of the Hill AFB waste site studies for developing an air rotary drilling plan for the field investigation.
1230	Conducted coordination calls with Construction Drilling International (CDI), UURI, UBTL and field equipment vendors; coordinating with Robert on field safety plan. Begin writing purchase orders for drilling contractors and supplies.
1330	Lunch.
1400	Resume field investigation activities. Contacted Keith Davis (Hill AFB) and Dr. Howard Ross (UURI) to set up a project orientation and meeting for Wednesday.
1600	Called UBTL and coordinated with Jim Nelson on field activities. He noted Jim Cochran will be assisting on the field project. We set up for Jim to meet at our Salt Lake City office Wednesday (20 October 1982) to purchase and pick up field safety equipment.
1630	Went to purchase and pick up waste site marking flags at Monsen Engineering Co. Returned to the office and resumed field development activities.
1900	End of day's activities.

RADIAN CORPORATION

Sheet 1 of 1

Log of Daily Activities

Date 20 October 1982 (Wednesday) Log Recorded By R. Belan

Project Hill AFB, IRP Phase II Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan (Radian), Dr. Howard Ross (ESL), Keith Davis (Hill AFB CE), Jim Cochran (UBTL)

Time (Military)	Activity or Event
0830	Begin day's activities. Went to Hill AFB and met with Keith and Howard. Keith oriented and briefed us on the waste sites after which he took us out to see them.
1200	Rick and Howard, after meeting with Keith, went to the base security to obtain base passes.
1230	Rick and Howard met to discuss base aerial photographs that Howard had with the waste sites on them. Rick borrowed the aerial photographs for study.
1300	Finished meeting with Howard and went to purchase field supplies.
1500	Returned to Radian SLC office. Met with Robert Vandervort for a field safety meeting with Jim Cochran (UBTL) on our soil sampling program for Thursday.
1620	Safety briefing completed Jim and Rick went to purchase and pick up field safety equipment.
1715	Rick went with Jim to UURI to pick up additional aerial photographs from Dr. Howard Ross.
1815	Returned to Radian (SLC) office and picked up field gear for Thursday soil sample coring.
1900	Break for dinner.
2000	Conducting aerial photograph analysis for spotting initial soil coring locations.
2130	End of day's activities.

RADIAN CORPORATION

Sheet 1 of 2

Log of Daily Activities

Date 21 October 1982 (Thursday) Log Recorded By R. Belan

Project Hill AFB, IRP Phase II Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan (Radian), Jim Cochran (UBTL), Phil Goodrich (Hill AFB CE), Keith Davis (Hill AFB CE)

Time (Military)	Activity or Event
0730	Begin soil sample inventory planning and control.
0845	Depart for Hill AFB to meet with Keith Davis (Hill Civil Engineering Division) and Jim Cochran (UBTL).
0905	Rick discussed preliminary aerial photograph interpretation on Chemical Disposal Pits Nos. 1, 2 and 3 with Keith Davis and Michael Trimeloni. Both are with the Base Civil Engineers. We discussed upcoming field activities.
1000	Rick called Farrell Peterson (CKI) to coordinate when he would like to view the waste site areas.
1030	Rick and Jim depart Civil Engineer office to begin soil sampling at Berman Pond.
1130	Hand augering at Berman Pond is going slow due to difficulty in hand augering. Augered materials are coarse gravels, pebbles and cobbles; looks like fill. No obvious contamination there other than asphaltic rubble on the surface.
1430	Completed initial augering and soil sampling at Berman Pond. Went to coordinate with Keith on a field storage equipment room and for anybody that might know of the history of the disposal of fluids at Chemical Disposal Pits Nos. 1 2 and 3. Keith noted that Phil Goodrich (Hill Civil Engineering Division) had disposed waste at the sites and could help.
1500	Rick, Keith, Jim and Phil went to Chemical Disposal Pits 1, 2, and 3. Phil described what he remembered occurring at each site.

RADIAN CORPORATION

Log of Daily Activities

Date 21 October 1982 (Tuesday)
Log Recorded By R. Belan
Project Hill AFB, IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian), Jim Cochran (UBTL)

Time (Military)	Activity or Event
1530	Keith and Phil depart. Jim and Rick begin soil coring at Chemical Disposal Pits Nos. 1 and 2. Coring was very difficult due to pebbles and cobbles. The augering at Chemical Disposal Pit 3 was easier but difficult to get samples out of the bit due to the "sticky clay" nature of the soil.
1700	Completed initial hand augering for the day, recorded samples and completed a chain of custody form. Sludge material was recovered in the vicinity of Chemical Disposal Pit 1 and 2, and solvent-smelling samples from Chemical Disposal Pit No. 3. Washed equipment. Went to Base Building 15 to drop off field equipment as arranged by Keith Davis.
1745	Completed equipment unloading and departed for the day.
2000	Working on day's activities and project analysis.
2130	End of day's activities.

RADIAN CORPORATION

Sheet 1 of 1

Log of Daily Activities

Date 22 October 1982 (Friday) Log Recorded By R. Belan

Project Hill AFB, IRP Phase II Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan (Radian), Keith Davis (Base Civil Engineer), Farrell Peterson (CDI)

Time (Military)	Activity or Event
0800	Continuing data review at Hill AFB. Began coordination with Base Bioengineering Division for collecting information and data on the project.
1000	Coordinated and briefed Radian home office (Austin, TX).
~1330	Keith and Rick meet with drilling contractor, Farrel Peterson (CDI) to discuss and show him the prospective drilling sites. We also discussed any questions he might have in addition to safety considerations.
~1430	Continuing data review and analysis at Base Civil Engineers.
1630	End of day's activities.

RADIAN CORPORATION

Log of Daily Activities

Date 23 October 1982 (Saturday)
Log Recorded By R. Belan
Project Hill AFB, IRP Phase II
Corresponding Tape # N/A
Location Ogden, Utah
Personnel on Site Rick Belan (Radian)

Time (Military)	Activity or Event
~0900	Completed locating an apartment in Ogden for living and conducting field office work near Hill AFB.
1500	Conducting data review and correlations for planning field investigation activities.
2000	End of day's activities.

RADIAN CORPORATION

Log of Daily Activities

Sheet 1 of 1

Date 24 October 1982 (Sunday) Log Recorded By R. Belan

Project Hill AFB, IRP Phase II Corresponding Tape # N/A

Location Ogden, Utah

Personnel on Site Rick Belan (Radian)

Time (Military)	Activity or Event
0900	Conducting data review of materials received from UBTL and Hill AFB Civil Engineers.
1800	End of day's data review. Begin monitor well field planning modifications based upon the data review.
1900	End of day's activities.

RADIAN CORPORATION

Sheet 1 of 1

Log of Daily Activities

Date 25 October 1982 (Monday) Log Recorded By R. Belan
Project Hill AFB, IRP Phase II Corresponding Tape # N/A
Location Salt Lake City, Utah
Personnel on Site Rick Belan (Radian)

Time (Military)	Activity or Event
0830	Coordinating project activities at the Radian (SLC) office. Begin developing our drilling subcontract and finalizing costs based upon data review conducted to date.
1050	Called Dr. Howard Ross (ESL) to discuss project and my data review results. My data review indicated possible metal objects may have been disposed of in Chemical Disposal Pits Nos. 1 and 2 and Landfill No. 3. I suggested to Dr. Ross that we may want to consider metal detector and/or magnetometer investigation to aid in spotting possible limits to the disposal sites. We would need to apprise Dr. Sim Lessley (UBTL) of this. Dr. Ross also wanted to see the results of their resistivity survey when they have completed as to the potential use of a magnetometer.
1315	Met with CDI; Farrell Peterson at his office on last minute drilling cost details and minor conceptual monitor well design changes.
~1430	Radian Salt Lake staff meeting.
1500	Coordinated with Robert Vandervort on the drilling subcontract with CDI. Coordinated with Radian contract section, Austin, Texas. Robert and I discussed the Hill AFB safety plan and special considerations.
1830	End of SLC activities.
2030	Continue writing the field drilling safety plan.
2230	End of day's activities.

RADIAN CORPORATION

Sheet 1 of 1

Log of Daily Activities

Date 26 October 1982 (Tuesday) Log Recorded By R. Belan
Project Hill AFB, IRP Phase II Corresponding Tape # N/A
Location Salt Lake City, Utah
Personnel on Site Rick Belan (Radian), Robert Vandervort (Radian)

Time (Military)	Activity or Event
0830	Working on drilling contract and discussion with Robert on same throughout day.
~0900	Called Dr. Ross (ESL) to coordinate field activities.
~0915	Called Dr. Lessley (UBTL), briefed and discussed project. Set up a meeting for 9:00 a.m. Wednesday.
~1000	Called Keith Davis (Hill AFB) to request information and coordinate project. He was not in the office. I left a message for him.
~1200	Went to pick up field vehicle in the shop.
1400	Received a call from Austin office on drilling sub-contract.
~1430	Briefed Ann St.Clair (Radian) on project status and up-coming events. Contacted Dr. Lessley and get telephone number of Jim Goodwin who had worked on the Landfill No. 4, in 1976.
1500	Returned calls from Keith Davis. We discussed project and information I need. He said he will look the infor-mation up. Called CDI and spoke with Mr. Peterson on obtaining final drilling cost for monitor well comple-tion modifications for monitor wells. Called vendors for protective equipment price quotes based upon final safety plan modifications.
1800	Completed statement of work. End of day's activities.

RADIAN CORPORATION

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Log of Daily Activities

Date 27 October 1982 (Wednesday) Log Recorded By R. Belan

Project Hill AFB, IRP Phase II Corresponding Tape # N/A

Location Salt Lake City, Utah

Personnel on Site Rick Belan (Radian), Robert Vandervort (Radian), Dr. Sim Lessley (UBTL), Dr. Howard Ross (ESL), Clive Mecham (Radian)

Time (Military)	Activity or Event
0730	Develop days activities and coordinate calls, depart for meeting with Sim and Howard in Salt Lake City.
0915	Meeting with UBTL and ESL, discussed project and up-coming activities.
~0930	R. Vandervort called R. Belan and discussed CDI costs.
4300	Back at Radian office working with Robett on subcontractual costs and refinements. Briefed Clive Mecham on field project assistance.
1500	Called Farrell Peterson (CDI) and discussed drilling details and costs.
1700	Contract test/cost packets are completed for distribution. Begin review of UBTL statement of work and made comments.
1730	Take CDI contract packet to Farrell Peterson.
1800	Contract delivered to CDI. Break-return to Odgens.
2100	Conducting preliminary aerial photo analysis of waste sites.
2230	End of day's activities.

RADIAN CORPORATION

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Log of Daily Activities

Date 28 October 1982 (Thursday) Log Recorded By R. Belan
Project Hill AFB, IRP Phase II Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian), Keith Davis (Hill AFB CE)

Time (Military)	Activity or Event
0800	Begin data review and logging data review entries.
1430	Met with Keith Davis and discussed project. Received Hill AFB data and information.
1630	Went out to study Chemical Disposal Pits 1, 2 and 3, the high ground golf course, and Base Wells 1, 2 and 3.
1800	Break.
1830	Working up latest data review material.
2000	End of day's activities.

RADIAN CORPORATION

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Log of Daily Activities

Date 29 October 1982 (Friday) Log Recorded By R. Belan
Project Hill AFB, IRP Phase II Corresponding Tape # N/A
Location Hill AFB
Personnel on Site Rick Belan (Radian), Robert Vandervort (Radian)

Time (Military)	Activity or Event
0830	Begin investigating the commercial gravel pits in the vicinity of the study area for developing hydrogeological assessment.
0900	Spoke with Ideal Rock Supply, South Weber, Utah, about ground water intrusions into their gravel operations. Went down inside pit to examine pit geology and potential relationships to our study area. Photographed gravel pit geology.
1015	Went to Chemical Disposal Pit No. 3 to meet and talk with ESL resistivity survey crew.
1105	Went to Hill AFB Bioengineer office to coordinate field activities.
1130	Went to Salt Lake office to coordinate with Robert Vandervort on project, draft responses to UBTL contract inquiries, and develop items for input to UBTL monthly report.
1230	Break.
1330	Discuss additional details of project with the program manager, Robert, and safety class with CDI next week. Continue working on project; made copies of field notes for distribution.
1500	Called Ann St.Clair at Austin and briefly discussed project and upcoming activities. Continued working on Hill AFB project.
1700	End of day's activities.

RADIAN CORPORATION

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Log of Daily Activities

Date 30 October 1982 (Saturday) Log Recorded By R. Belan

Project Hill AFB, IRP Phase II Corresponding Tape # N/A

Location Ogden, Utah

Personnel on Site Rick Belan (Radian)

Time (Military)	Activity or Event
0900	Working up and logging general notes, activities and made coordination calls.
1030	End of day's activities.

RADIAN CORPORATION

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Log of Daily Activities

Date 1 November 1982 (Monday) Log Recorded By R. Belan

Project Hill AFB, IRP Phase II Corresponding Tape # N/A

Location Salt Lake City, Utah

Personnel on Site Rick Belan (Radian)

Time (Military)	Activity or Event
0830	Begin developing monthly report input to UBTL and working on project data.
11:30-1300	Break.
1325	Called Dr. S. Lessley's (UBTL) and discussed project and sub-contract. Added some items to monthly report based on conversation with Dr. Lessley. Arranged for soil sampling with UBTL on Tuesday at Chemical Disposal Pits 1 and 2.
1425	Called UURI and spoke with Claron Mackelprang (ESL) and discussed the preliminary resistivity survey results on Chemical Disposal Pit 3 which should be ready Tuesday.
~1440	Called Austin office and coordinated with personnel on project related items.
~1500	Called CDI and left message for Wednesday field safety class.
1800	Finished draft monthly report input to UBTL; made a review copy for R. Vandervort. Begin preparing for Tuesday soil sampling effort at Chemical Disposal Pits 1 and 2.
1900	End of day's activities.

RADIAN CORPORATION

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Log of Daily Activities

Date 2 November 1982 (Tuesday) Log Recorded By R. Belan

Project Hill AFB, IRP Phase II Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan (Radian), Jim Cochran (UBTL)

Time (Military)	Activity or Event
0730	Making Chemical Disposal Pit 1 and 2 soil sample plan. Departed to Hill AFB to pick up field gear from base Civil Engineer's office.
0845	Flagged Chemical Disposal Pits Nos. 1 and 2 for the next series of soil samplings. This sampling episode will be with a shovel, due to last episodes being so difficult with a hand auger.
0915	Jim Cochran and Rick begin soil sampling.
1230	Finished taking 18 soil samples at Chemical Disposal Pits 1 and 2. Washed up field gear and took back to base Engineer office. Released samples to UBTL.
1300	Took Jim Cochran to Hill AFB Security for getting an I.D. and vehicle pass.
1345	Begin developing details for a conceptual drilling plan for CDI monitor well installation.
1450	Called Claron Mackelprang (ESL) and discussed results of their initial resistivity survey at Chemical Disposal Pits 1 and 2.
1505	Called Robert Vandervort (Radian) and discussed field activities. The driller (CDF) safety class will now be Thursday at 3:00 p.m. Also, the monitor well stainless steel screens will not be shipped until 5 November, therefore the field drilling start will probably be next Tuesday (9 November 1982).
1520	Called Dr. S. Lessley (UBTL) and discussed and updated him on project. Coordinated their soil sampling assistance for this Thursday (4 November 1982) at Chemical Disposal Pit 3.

RADIAN CORPORATION

Log of Daily Activities

Date 2 November 1982 (Tuesday)
Log Recorded By R. Belan
Project Hill AFB, IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian), Jim Cochran (UBTL)

Time (Military)	Activity or Event
1607	Called the Utah Department of Natural Resources - Water Rights Division to request information about any special requirements about biodegradable drilling fluids. It was best to see the publications they have which may answer my question. I need to pick up their literature to read.
1730	End of day's activities.

RADIAN CORPORATION

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Log of Daily Activities

Date 3 November 1982 (Wednesday)
Log Recorded By R. Belan
Project Hill AFB, IRP Phase II
Corresponding Tape # N/A
Location Salt Lake City, Utah
Personnel on Site Rick Belan (Radian)

Time (Military)	Activity or Event
0730	Conducting field planning activities for Thursday soil sampling. Checked with Hill AFB Civil Engineer on assistance to change out auger bits.
1030	Conducting well records review at Utah Department of Natural Resources Water Rights Division, as well as inquiring about water well drilling regulations and use of biodegradable drilling fluids. I spoke with Donald Norseth about biodegradable drilling fluid. He didn't see any problems with them and noted few drillers have used it and normally don't because of its expense. He noted Boyles Brother drilling may have used it.
1230	Ended initial well log data collection on or about Hill AFB for hydrogeologic review went to office to work up activities. Reviewed our monthly report to UBTL. Discussed project with Robert Vandervort, the program manager.
1545	Went to pick up preliminary resistivity survey results from UURI in addition to their Geothermal report on Hill AFB.
1620	Returned Dr. Sim Lessley's call. Jim Cochran (UBTL) will be in the field Thursday for soil sampling and would also like a Quality Control (QC) soil sample. We discussed potential locations for obtaining a QC soil sample.
1700	Return to Ogden, break.
1900	Begin reviewing preliminary resistivity survey results at Chemical Pit No. 3 for applying to Thursdays soil coring plan. Developing soil coring plan.
2030	End of day's activities.

RADIAN CORPORATION

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Log of Daily Activities

Date 4 November 1982 (Thursday) Log Recorded By R. Belan
Project Hill AFB, IRP Phase II Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian), Jim Cochran (UBTL), Robert Vandervort (Radian), Ferrell Peterson, Odell Burns, Dan Hill, Bill Lindstrom (CDI)

Time (Military)	Activity or Event
0730	Preparing for field soil sampling activities; went to Hill AFB and picked up field auger, equipment, and to get additional field supplies. Checked with Civil Engineer on possible location for QC sample.
0845	Begin Chemical Disposal Pit No. 3 soil sampling and sample location flagging. Jim (UBTL) assisted. Collected 15 soil and waste samples which includes a QC soil sample from North perimeter of Base.
1400	End of field sampling activities, took field gear to drop off at base Civil Engineer's. Departed for CDI field safety briefing and to visit USGS in Salt Lake City.
1430	At USGS for data and map pickup. Locked out of car. Called for Holiday rental for assistance.
1545	Car unlocked and have USGS information, depart to office for safety briefing with CDI.
1605	Safety meeting with Robert Vandervort and CFI on safety for project. CDI persons attending Farrell Peterson, Odell Burns, Dan Hill, and Bill Lindstrom. Robert Vandervort conducted at the safety briefing and Rick Belan provided technical drilling safety aspects. Royal Taylor (CDI) was not present.
1715	End of safety briefing. Robert Vandervort and Rick Belan discuss project and contractual comments from UBTL. Working up project information. Farrell said that he will try to get the rig on Hill AFB and set up on the first drill hole; he will also get the base badges for working on base.
1800	Break.
1930	Working up a preliminary drilling well installation priorities and well depth estimates.
2200	End of day's activities.

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Sheet 1 of 2

Log of Daily Activities

Date 5 November 1982 (Friday) Log Recorded By R. Belan
Project Hill AFB, IRP Phase II Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian), LTC Maynard Moody (Hill AFB), Maj. Capell (Wright Patterson AFB)

Time (Military)	Activity or Event
0805	Called CDI and spoke with Farrell Peterson to coordinate well screen material sizes and well bailing development.
0815	Called Radian, Austin and spoke with Larry French on shipping out pumping equipment and bailer for sampling the M-wells. Also coordinated with Ann St.Clair and William Little.
0905	William Little called me and coordinated field materials. Called Hill AFB Civil Engineer to coordinate monitor well staking activities.
0925	Called Salt Lake office for coordination with Robert Vandervort. We discussed the project. Clive Mecham (Radian) is helping to get field safety equipment.
1100	Nodified Hill AFB Security that CDI may be coming in today or Monday to get base badges and passes. Went to Keith Davis for coordination and discussion on project. Prepared monitor well stakes for locating wells.
1300	Went to stake Berman Pond and Chemical Disposal Pit 3.
1400	Briefed base Bioengineer LTC Moody (Hill AFB) and Maj. Capell (Wright Paterson AFB) on start-up of field activities and integration of various data for field program planning and execution.
1520	Ended briefing. Went to Civil Engineer's office.
1530	Talked with Keith Davis, Mike Trimeloni on project and barrels availability for holding monitor well water.
1545	Called CDI and spoke with Farrell Peterson and discussed the methodology for sealing of the monitor well surface casing.
1615	Depart Civil Engineer's and go to finish monitor well location staking at Chemical Disposal Pits 1 and 2 and Landfill No. 3.

RADIAN CORPORATION

Log of Daily Activities

Date 5 November 1982 (Friday)

Log Recorded By R. Belan

Project Hill AFB, IRP Phase II

Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan (Radian), LTC Maynard Moody (Hill AFB), Maj. Capell (Wright Patterson AFB)

Time (Military)	Activity or Event
1745	Completed staking locations for monitor wells. Also walked the area to observe the hydrogeological setting. Break.
2030	Working up administrative paper work.
2200	End of day's activities.

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Log of Daily Activities

Date 8 November 1982 (Monday) Log Recorded By R. Belan
Project Hill AFB, IRP Phase II Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian), Gordon Allcott (Radian), Dan Hill (CDI), Bill Lindstrom (CDI), Royal Taylor (CDI), Al Simmons (Hill AFB)

Time (Military)	Activity or Event
0730	Begin field activities for setting up drilling activities. Departed to Salt Lake office for coordination and pick up of additional field equipment.
0800	Flat tire. Repair at 0830 resume going to Salt Lake City.
~0915	Discussed drilling field safety program with Gordon Allcott (Radian) and field program implementation.
1030	Called CDI and spoke with Farrell Peterson about today's activities and base access. He plans to be out at Hill AFB today about 2:00 p.m. I prepared a letter for base access for CDI.
1145	Picked up field protective gear at Surety Supply.
1220	CDI called and wanted to know about their going to Hill AFB. They were going to leave for the base after 12:30.
1230	Called Dr. Lessley (UBTL) and discussed project.
1250	Received a call from Timco Mfg. field sampling bailer to arrive Tuesday via Burlington Northern Services.
1320	Depart for Hill AFB to meet CDI, and coordinate with base Civil Engineers.
1400	Met with base Civil Engineers and received work clearance permit for drilling. Discuss project, and find that several Civil Engineer offices need to physically see staked locations for monitor wells.
1415	Called water line number (63081) and arranged for someone to come out to spot stakes. No one available today so set up for 8:00 a.m. Tuesday by Landfill No. 3. Called base cable communication (76464) for monitor well stake spotting, and somebody can be out at Landfill No. 3 area at approx 3:00 p.m.

RADIAN CORPORATION

Log of Daily Activities

Date 8 November 1982 (Monday) Log Recorded By R. Belan

Project Hill AFB, IRP Phase II Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan (Radian), Gordon Allcott (Radian), Dan Hill (CDI), Bill Lindstrom (CDI), Royal Taylor (CDI), Al Simmons (Hill AFB)

Time (Military)	Activity or Event
~1425	Went to meet CDI at Landfill No. 3 and met Dan Hill, Bill Lindstrom and Royal Taylor. They had received their temporary base passes. They were prepared to drop the air rotary drilling rig off at the first monitor well to be drilled. I took them to Monitor Well No. 1 location and discussed the project.
1445	CDI personnel departed for the day. Plan to return Tuesday morning with the rest of supporting drilling equipment.
1450	I met Mr. Maroney of the base electrical distribution office and he cleared the present monitor well stake locations.
1515	Met Al Simmons from base communications and briefed him on the monitor well location that I have staked. He indicated the position looked OK for most, but he will be back out 8:00 a.m. Tuesday to finalize.
1535	Finished staking remaining monitor wells.
1545	Began conducting a topographic and hydrographic reconnaissance of the potential relationship of the golf course to the Landfill No. 3 and Chemical Disposal Pit Nos. 1 and 2 areas.
1700	Completed golf course reconnaissance for the day. Break
1730	Reviewing CRI report and potential relationship to golf course area.
1930	Finalizing day's activities and planning Tuesday drilling operations. Picked up expendable field items.

RADIAN CORPORATION

Log of Daily Activities

Date 9 November 1982 (Tuesday)   Log Recorded By R. Belan

Project Hill AFB, IRP Phase II   Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan (Radian), Gordon Allcott (Radian); Farrell Peterson, Royal Taylor (CDI)

Time (Military)	Activity or Event
0730	Work on today's drilling and well staking activities.
0800	Dropped off CDI pass list with base security.
0815	Al Simmons (Communication) came to Monitor Well M-1 and was checking out the locations. He noted Berman Pond, and Chemical Disposal Pits No. 1 and 2, Landfill No. 3 well stakes looked OK.
0830	Al Simmons returned and indicated that all stakes were OK but that M-6 and 7 were located about 7 feet east of their line. I said I will move them further east and south to allow greater margin of safety. I went and moved them about 20 feet east and 20 feet south. Al noted that he thought Mountain Bell may have lines in the area of Chemical Disposal Pit 3.
0900	Back at Bldg. 15 Civil Engineers to pick up safety gear and call base water line inspection who has not been out at the sites yet to check out locations.
0945	Called CDI, they are gathering up equipment and plan to be out this afternoon.
1010	Met with water line personnel discussed monitor well locations. I need to move Monitor Wells Nos. 6, 7, 13 and double check 14. They mentioned that the Corps of Engineers were now doing soil borings in the Berman Pond area.
1055	Finished with water line personnel went to Bldg. 15 Civil Engineer. Conducted data review of additional information brought to my attention.
1335	Coordinated with Maj. Gaudet (Bioengineers) on using a refrigerator/freezer for soil samples storage and a key for access to the sample refrigerator.
1350	Went to see if CDI on site at M-Well M-1; not yet.

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Log of Daily Activities

Date 9 November 1982 Log Recorded By R. Belan
Project Hill AFB, IRP Phase II Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian), Gordon Allcott (Radian) Farrell Peterson, Royal Taylor (CDI)

Time (Military)	Activity or Event
1410	Called CDI and they are finalizing equipment loading. They'll call me at 777-2065 to let me know when they are leaving.
1415	Called Salt Lake office and Gordon Allcott had already left to come up. Also field bailer was not received.
1435	Called UURI and spoke with Dr. Howard Ross. They will probably not be able to get to finish the preliminary resistivity survey of Chemical Disposal Pit No. 3 until Thursday (11 Nov. 82). We discussed the project, and possibilities for other survey lines at Base Well No. 4 and golf course area.
1500	CDI has departed for Hill AFB.
1520	Met with Gordon discussed field project and his safety monitoring.
1600	CDI on site and began drilling activities for Monitor Well No. 1. Drilling crew is Farrell Peterson and Royal Taylor.
1640	CDI put protective clothing on and prepared to set surface pipe. Briefed Royal on use of protective equipment. CDI begins initial drilling.
1800	End of day's activities.

RADIAN CORPORATION

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Log of Daily Activities

Date 10 November 1982 (Wednesday) Log Recorded By R. Belan
Project Hill AFB, IRP Phase II Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian), Gordon Allcott (Radian)

Time (Military)	Activity or Event
0730	Begin day's activities. Go to pick up bailing and soil sample accessories at base Civil Engineer's. Raining this morning.
0855	Called CDI. The monitor well screens are to be delivered and have not arrived yet. Conduct additional data review at base Civil Engineer's.
0915	Called Dr. S. Lessley (UBTL) and discussed project.
0930	Called ESL and spoke with Claron Mackelprang and talked about the location of their resistivity equipment. He noted it's to be shipped to Hill AFB base Friday. They should be able to resume work on Monday.
0935	Called Dr. M. Ridd, UURI Center for Remote Sensing and Cartography. I inquired about a study they conducted (dated 1980) which may be useful for this present Hill AFB study.
1015	Requested detailed utility maps of storm drainage and sanitary sewage systems for the study areas from the base Civil Engineer.
1045	Called Ray Harvey in reference to a Berman Pond sanitary drainage line. He wasn't in so I left a message to call me. If I am not in, he is to talk with Keith Davis or Mike Trimeloni.
1120	CDI called and will be ready about 1:00 p.m. Farrell Peterson needs to call office as soon as possible.
1130	Keith Davis received a call from Patrick AFB, George Hodgco (?) and relayed that the ESLF geophysical equipment will probably arrive next Monday or Tuesday. The shipping number is TCN # FB28292314X903XXX.
1135	Called Claron Mackelprang (ESL) and relayed about equipment coming from Patrick AFB. Claron noted his record showed the last 3 numbers of the shipping number was a 703 instead of a 903.

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Log of Daily Activities

Date 10 November 1982 (Wednesday)

Log Recorded By R. Belan

Project Hill AFB, IRP Phase II

Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan (Radian), Gordon Allcott (Radian)

Time (Military)	Activity or Event
1145	Went and moved Berman Pond monitor well stake locations to clear utility pipes.
1200	CDI on-site and setting up for drilling. Begin drilling operations on Monitor Well M-1.
~1500	Gordon on-site and reviewing safety on-site and of drilling operations.
1800	Completed setting 5-feet of 6-inch stainless steel telescoping screen. End of day's drilling activities.
1818	I took two soil samples collected during drilling of Monitor Well M-1 to the refrigerator at Base Bioengineer. Building secured when I left.
1830	End of day's activities.

RADIAN CORPORATION

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Log of Daily Activities

Date 11 November 1982 (Thursday) Log Recorded By R. Belan
Project Hill AFB, IRP Phase II Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian), Farrell Peterson; Royal Taylor (CDI).

Time (Military)	Activity or Event
0730	Begin field activity for Monitor Well M-1 and went to site.
0750	No one here yet. I took a static water level measurement and sounded bottom of Monitor Well M-1. Static water level at 23.2 feet and sounded bottom at 31.0 feet BGL.
~0850	Called Dr. S. Lessley (UBTL) and briefed him on activities.
0915	Returned back to Monitor Well M-1 and the driller was on site. They are just beginning to rig down and wash up equipment for moving over to Monitor Well M-2.
1110	Moved to Monitor Well M-2 location. Suited up protective clothing and begin drilling activities.
1445	Completed basic drilling, construction and screen setting of Monitor Well M-2. CDI preparing to rig down and move to Monitor Well M-4.
1520	CDI rig set up at Monitor Well M-4 and begin drilling. Drilled to 16 feet, CDI end of day's drilling activities.
1545	Stand down complete and depart for the day.
1615	I took soil samples collected at Monitor Well M-2 (10 to 16 feet and 25 to 35 feet) to store in Bioengineer refrigerator. Entry door was secured when I departed to Salt Lake City office.
1700	Arrive at Salt Lake office went to staff meeting.
~1800	End of meeting and day's activities.

RADIAN CORPORATION

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Log of Daily Activities

Date 12 November 1982 (Friday) Log Recorded By R. Belan

Project Hill AFB, IRP Phase II Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan (Radian); Farrell Peterson, Royal Taylor (CDI).

Time (Military)	Activity or Event
0730	Begin day's field activities and dropped off field materials at Base Civil Engineer. Mike Trimeloni (Civil Engineer) briefed me on Mr. Harvey's return call concerning an old drain pipe in Berman Pond that he inquired about.
0845	Went to Monitor Well M-2 to measure static water level and sounded the bottom.
0915	Driller (CDI) not on-site yet.
0920	Went to the golf course and spoke with Wayne Bull on the history of golf course, particularly the hydrologic aspects. Went to view some features described by Wayne.
1015	Driller on-site resuming Monitor Well M-4 drilling construction activities.
1330	Completed Monitor Well M-4, now drilling rig set up on Monitor Well M-9 and begin operations.
1400	Drill and drove to 15 feet hit clay at 7 feet. Took two soil samples. Driller broke down for the day. Need to decide what to do with this well as no apparent ground water and as clay was very shallow. Decided to cover and let well sit over the weekend to see if any ground water.
1420	Measured excess casing cutoff and stock up of 6-inch casing.
1430	Took Monitor Well M-9 soil samples to Bioengineer refrigerator. Spoke with LTC Moondy and Maj. Gandet.
1450	Took field equipment to Civil Engineer and talked with personnel there. Departed for Salt Lake office.

RADIAN CORPORATION

Log of Daily Activities

Date 12 November 1982 (Friday) Log Recorded By R. Belan

Project Hill AFB, IRP Phase II Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan (Radian); Farrell Peterson, Royal Taylor (CDI).

Time (Military)	Activity or Event
~1655	Arrived Salt Lake office and attended a staff meeting, briefed Robert Vandervort on project. Worked up project administration items.
1815	End of day's activities.

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Log of Daily Activities

Date 13 November 1982 (Saturday)   Log Recorded By R. Belan
Project Hill AFB, IRP Phase II   Corresponding Tape # N/A
Location Ogden, Utah
Personnel on Site Rick Belan (Radian)

Time (Military)	Activity or Event
0915	Worked on drilling program field notes. Planned well completion options for Monitor Well M-9. Reviewed Hill AFB geology developed this week versus past geologic data.
~1200	End of day's activities.

RADIAN CORPORATION

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Log of Daily Activities

Date 15 November 1982 (Monday) Log Recorded By R. Belan
Project Hill AFB, IRP Phase II Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian)

Time (Military)	Activity or Event
0815	Begin data review and project analysis.
1115	Break.
1200	Coordinating and planning field activities.
1245	Contacted Farrell Peterson (CDI) for coordinating well drilling activities, and discussed the completion of Monitor Well M-9.
1305	Contacted Dr. H. Ross, ESL and coordinated resistivity survey field work.
1315	Contacted Dr. S. Lessley, UBTL. Briefed him on field progress and up-coming activities. Discussed potential monitor well alternate locations as well as for resistivity surveys based upon most recent data received. I had recommended a golf course monitor well and Dr. Dee Ann Sanders (Brooks AFB) agreed to the principal.
1515	Contacted Earl Stokes, U.S. Army Corps of Engineers, California. Requested soil boring information on their very recent foundation work particularly around Berman Pond. He indicated that he would check and contact me back.
1600	Contacted Mr. McQuivi (?) of U.S. Army Corps of Engineers, Salt Lake City. I requested, if available, soil boring logs from previous base investigations around 1959. He would check on it and get back to me.
1630	Break.
2100	Working up data review for monitor well planning.
2230	End of day's activities.

RADIAN
CORPORATION

Log of Daily Activities

Date 16 November 1982 (Tuesday)
Log Recorded By R. Belan
Project Hill AFB, IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian), Royal Taylor (CDI), Claron Mackelprang (UURI); Keith Davis, Mike Trimeloni, Bill Taylor (Hill AFB CE)

Time (Military)	Activity or Event
0800	Begin field activities at base Civil Engineers. Picked up field gear and soil sample bottles.
0835	I received a call from CDI that Farrell will not be able to be out today and that Royal will be out to drop off pipe, water tank and general site preparations.
0845	Briefed Keith, Bill and Mike of base Civil Engineers on field progress.
0940	Called Dr. H. Ross (ESL) to coordinate field activities later this morning.
1020	Met Royal, CDI at Monitor Well M-9. He is working at site and is ready to drop casing at prospective deep holes. I took him to a well location at Landfill No. 3 and Berman Pond for droping off casing. He is supposed to drop casing at all deep well locations. I said lets talk with Farrell because until we drill the first deep well we won't know what is below the clay or depth to ground water in order to plan casing requirements.
1100	Called CDI and Farrell is not available yet should be in about noon.
1115	Went to Chemical Disposal Pit No. 3 and ESL is finishing setting up of first resistivity transect. Received Geothermal Well No. 1 geophysical logs, and present work up on Line 1 resistivity survey computer modeling.
1140	Called CDI and let know my contact telephone number.
1230	Called Farrell and explained my concern over laying out all deep well casing. He indicated he would rather have all casing layed out so as to have it on base if needed. I said fine, I will relay to Royal.
1255	At Monitor Well M-9. Royal on site working. Pulling drill pipe and end of it has ~5 feet of water in it. Show Royal the potential deep weels for laying out casing.

RADIAN
CORPORATION

Sheet 2 of 2

Log of Daily Activities

Date 16 November 1982 (Tuesday)
Log Recorded By R. Belan
Project Hill AFB, IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian), Royal Taylor (CDI), Claren Mackelprang (UURI); Keith Davis, Mike Trimeloni, Bill Taylor (Hill AFB CE)

Time (Military)	Activity or Event
1330	Went to Chemical Disposal Pit No. 3 and spoke with Claron Mackelprang (ESL) and exchanged data for our projects. Base civil engineers also present K. Davis, M. Trimeloni, and B. Taylor.
1355	Went to Monitor Well M-4 to take a static water level measurement and sound it.
1430	Conducted final day's check with CDI R. Taylor and C. Mackelprang (ESL).
1500	Returned to base Civil Engineer's and review data supplied by UURI. Coordinated with Salt Lake Radian office.
1600	Called Radian Austin office to coordinate, and spoke with William Little on recent air rotary drilling results from a California project as applicable to our present Hill AFB project.
1700	Break.
1830	Resume well log data review for planning deep wells.
2030	End of day's activities.

RADIAN CORPORATION

Sheet 1 of 2

Log of Daily Activities

Date 17 November 1982 (Wednesday)

Log Recorded By Rick Belan

Project Hill AFB IRP Phase II

Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan (Radian); Farrell Peterson, Royal Taylor (CDI)

Time (Military)	Activity or Event
0800	Picked up field gear at Base Civil Engineer's, proceeded to Monitor Well M-9. Measured well casing and drive shoes. Driller not on-site yet.
0950	Called CDI and they left their office about 20 minutes before. Returned to Monitor Well M-9.
1010	Farrell, Royal on-site working on M-9 emplacing slotted plastic pipe and gravel in well annulus.
1100	Completed drill pipe wash down and begin to move to Monitor Well M-7.
1215	Begin drilling and driving of Monitor Well M-7, clay at 17 feet.
1316	CDI dropped stainless steel screen in 6-inch casing prepare well to pull 6-inch casing. There was a problem with pulling casing. Farrell Peterson noted some gravels stuck in the screen and maybe some screen damage but still useable, he did not detect any ground water. I previously noted strong moisture returns and decided to complete the well. Completed Monitor Well M-7.
1415	Moving to Monitor Well M-6 which is to be a deep well.
1445	CDI is ready to drill Monitor Well M-6, Farrell Peterson only plans to set 8-inch casing into clay for today. Clay at ~23 feet.
1725	CDI is done for the day, Farrell Peterson noted that clay was at 13½ feet and not 17 feet at Monitor Well M-7. They depart for the day.
1730	Rick making double check measurements on Monitor Well M-7 as my data with CDI doesn't agree.
1800	Completed measurements and observations, take soil samples to freezer at Base Bioengineer.
1830	Break.

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Log of Daily Activities

Date 17 November 1982 (Wednesday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian); Farrell Peterson, Royal Taylor (CDI)

Time (Military)	Activity or Event
1900	Called Robert Vandervort to discuss my concerns about M-7 materials setting as I believe driller is in error.
1930	Begin working up well data to cross-check CDI drillers logs and first week invoice that I received from Farrell Petterson today.
2230	End of day's activities.

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CORPORATION

Sheet 1 of 2

Log of Daily Activities

Date 18 November 1982 (Thursday) Log Recorded By Rick Belan
Project Hill AFB IRP Phase II Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian); Claron Mackelprang (UURI); Royal Taylor, Farrell Peterson (CDI)

Time (Military)	Activity or Event
0730	Working on Monitor Wells M-6 and M-7 activities.
0800	Went to Base Civil Engineer's to obtain water hose and hydrant key for CDI from Base Fire Department for rig and equipment wash down. Coordinated with Keith Davis on a golf course monitor well location.
0830	Called CDI to coordinate activities. Farrell and I discussed Monitor Well M-7. Farrell noted he had made a mistake and that the screen had accidently jammed and that the depth to clay was as originally noted 16½ feet (∿17 feet). He will pull and repair at his cost after completing Monitor Well M-6.
0910	Called Dr. S. Lessley (UBTL) for coordination and set up of a possible project meeting with LTC. Mooney on Friday. I noted my attendance is conditional on what is happening with the drilling.
1010	Discussing the project with Keith Davis and received a water detecting paste. Also found out that they may possibly get an oil-skimming pump system to use at Chemical Disposal Pits 1 & 2. I noted to Keith it would be a good idea to wait for our results in the area before implementing an oil recovery system.
1030	Called CDI. Farrell Peterson noted that their drill foam has not come in yet. They have a lot of things to do and will not be drilling today.
1035	Called Dr. S. Lessley (UBTL) to see if our meeting can be today. If we cannot we will shoot for next Wednesday morning.
1045	Went to Monitor Well M-6 to drop off 50 foot fire hose hydrant key and hydrant adapter for CDI. I placed them inside CDI truck. Saw UURI working at Berman Pond.
∿1105	Stopped and talked with Claron about their resistivity survey at Berman Pond.

RADIAN CORPORATION

Log of Daily Activities

Date 18 November 1982 (Thursday)

Log Recorded By Rick Belan

Project Hill AFB IRP Phase II

Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan (Radian); Claron Mackelprang (UURI); Royal Taylor, Farrell Peterson (CDI)

Time (Military)	Activity or Event
1120	At Monitor Well M-6 Royal and help on-site doing general work, no well drilling.
1200	Back at Civil Engineering and talked with Keith Davis and picked up a new tube of oil/water marking paste.
∿1245	Screening the geology of southern and eastern areas of the base. Went to Weber County Landfill, observed landfill topographic cuts and described general formations. Went to view Landfills 3 and 4 area from the north side of Weber River Canyon.
1400	Break.
1430	Resume investigative field activities.
1500	Called Austin office and spoke with William Little on project materials chemical resistance, Ken Lee may have additional information of materials (i.e., ABS plastic).
1545	Dropped off field gear at Civil Engineers.
1615	Scoping out golf course and unlined open water tank just east of golf course club house.
1700	Finished viewing golf course area, break.
∿1830	Working up soil sample inventories, and preparing static water level line equipment.
2000	End of day's activities.

RADIAN CORPORATION

Log of Daily Activities

Date 19 November 1982 (Friday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian); Farrell Peterson, Royal Taylor (CDI)

Time (Military)	Activity or Event
0800	Working up day's activities and coordination calls. Weather is not good.
0840	Called CDI on drilling status. Farrell Peterson said because of the bad wet weather this morning we will make a determination about 9:30 a.m. if they will drill today.
0850	Called Robert Vandervort and discussed project. He took care of the field car mileage with Holiday Car Rental for me.
0900	Called Dr. S. Lessley (UBTL) and discussed project. 1. 10 a.m. Wednesday we will meet with LTC. Moody and have pre-meeting at about 9 a.m. between Rick Belan, Sim Lessley and Howard Ross which should be good to discuss internal project matters. 2. Robert Vandervort will probably attend meeting.
0915	Went to Bioengineer and exchanged soil sample custody for them to hold until UBTL picks them up today. Soil samples are for Monitor Wells M-1, M-2, M-4, M-9, and M-7.
0950	Called CDI, they will drill today and informed Farrell that next Wednesday I have a meeting, he noted he does also, and would probably not be at Hill AFB.
1000	Called UBTL and talked with Dr. Sim Lessley that drilling activities will be today and soil samples can be picked up with Sheila at LTC. Mooney's office. Discussed that I need resistivity results as it has been a month, particularly for Chemical Pit 3. Discussed project with base civil engineers.
1035	Relayed activity changes for Robert Vandervort.
1050	Reconing golf course.

RADIAN CORPORATION

Log of Daily Activities

Date 19 November 1982 (Friday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian); Farrell Peterson, Royal Taylor (CDI)

Time (Military)	Activity or Event
1300	CDI arrive at site to begin drilling activities on Monitor Well M-6. Drilled open hole below the 8-inch casing to a depth of ~77 feet. No distinct sand zones below clay could be picked. Seems to have lots of very thin sand/silt lenses.
1515	Snow storm hit along with extreme drops in temperature, some hail.
1545	End of drilling activities due to weather. Farrell and I discuss allowing M-6 to sit and see if a static water level measurement could be taken. To date, Farrell and Royal have been the only CDI personnel constructing wells on Hill AFB.
1600	Took field equipment to base civil engineers.
1615	Called Radian Austin office and discussed Monitor Well M-6 well completion potential and special considerations with Larry French.
~1630	Called UURI and spoke with Dr. Howard Ross and discussed the need for preliminary resistivity survey results particularly on Chemical Disposal Pit No. 3.
~1730	End of day's activities.

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CORPORATION

Sheet 1 of 1

Log of Daily Activities

Date 20 November 1982 (Saturday) Log Recorded By Rick Belan
Project Hill AFB IRP Phase II Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian)

Time (Military)	Activity or Event
~1835	Called William Little (Radian) to discuss Monitor Well M-6 completion potential based upon special problem and considerations. William Little has recently completed a deep well in a similar type formation.

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RADIAN CORPORATION

Sheet 1 of 1

Log of Daily Activities

Date 21 November 1982 (Sunday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian)

Time (Military)	Activity or Event
1130	At Monitor Well M-6 to take static water level measurements and sound the bottom. The bottom had filled in from ∿77 feet below ground level back to ∿35 feet below ground level. Definite ground water, but distinct water bearing zones not apparent.
1230	End of day's field data collection.
1815	Called William Little to discuss my data collected today on Monitor Well M-6 and application to my well completion plan.
∿1830	Called Ann St.Clair to brief on general field station and to confir on Monitor Well M-6 situation. I then worked on general project activities for Monday.
2100	End of day's activities.

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CORPORATION

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Log of Daily Activities

Date 22 November 1982 (Monday) Log Recorded By Rick Belan
Project Hill AFB IRP Phase II Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian); Keith Davis (Hill AFB CB); LTC. Maynard Moody (Hill AFB Bioengineer); Farrell Peterson, Royal Taylor, Arlynd Himdall (CDI)

Time (Military)	Activity or Event
0800	Met with Civil Engineer Keith Davis and discussed project. I also inquired about the base culinary water storage tanks and drain lines in the vicinity of the golf course.
0835	Called CDI and spoke with Farrell Peterson and Monitor Well M-6 completion plan and the day's activities. Also noted that for a gravel pack at Monitor Well, M-7 needs to be rounded.
0900	At Bionegineer picked up soil sample bottles, spoke with LTC. Moody on project and arranged for a conference room for Wednesday meeting.
0930	Called Dr. Sim Lessley (UBTL) to discuss Wednesday's meeting and status on Monitor Well M-6.
1010	CDI just arrived on site and begin working on Monitor Well M-6. Preparing for setting of the screen welding casing. etc. Arlynd is now on site, briefed him on safety program and personal protective gear.
1318	Called Radian and picked up messages. Briefed Robert Vandervort on project. Returned to CDI drilling activity.
1530	Completed setting screen at Monitor Well M-6 and preparing to work on Monitor Well M-9.
1600	CDI pulled out screen and will prepare hole and casing for 4-inch plastic slotted pipe for completion.
1705	Wash down drill pipe and low off rig to clean up. Received a copy of second invoice from Farrell Peterson.
1730	End of field activities; break.
1900	Reviewed CDI invoice and budget.
2000	End of day's activities.

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RADIAN CORPORATION

Sheet 1 of 2

Log of Daily Activities

Date 23 November 1982 (Tuesday)

Log Recorded By Rick Belan

Project Hill AFB IRP Phase II

Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan (Radian); Royal Taylor, Arlynd Himdal (CDI); Keith Davis (Hill AFB CE); Wayne Sugamoto (Hill AFB GC); Bill Taylor (Hill AFB CE): Claron Mackelprang (UURI)

Time (Military)	Activity or Event
0700	Working on field data and interpretation.
0800	Break to 0830.
0850	Called CDI to coordinate activities and leave message about second invoice. Picked up field gear at base civil engineers.
0900	Keith Davis noted that the resistivity survey equipment was located and delivered to UURI. The weather is still very cold.
0916	Called CDI left message for Farrell Peterson - reference his second invoice. Also found that Royal and Arlynd were coming out to prepare drilling rig for next monitor well.
0930	At M-6 CDI on-site, Royal and Arlynd are getting ready to begin activities to move to the next site Monitor Well M-10.
~0950	Went to the golf course and spoke with Wayne Sugamoto about golf course and general hydrogeologic setting. Left for base engineer.
1025	Saw UURI at Berman Pond and they noted the ground was frozen. Claren Mackelprang asked if a pick is available to dig their electrode holes. I said I'll check with the base engineers as that's where I'm headed.
1035	At base engineers and was given a pick by Bill Taylor.
1100	Returned call to L. McQuivi, Salt Lake City, U.S. Army Corps of Engineers. They could not find Berman Pond soil borings related information that I requested. He noted that Bob Smith the resident Corp Engineer representative at Hill AFB may have more recent information.
1120	Gave base civil engineer pick to UURI at Berman Pond. Went to restake Monitor Well M-10 location to aid in developing lateral geology from Monitor Well M-9.

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RADIAN CORPORATION

Log of Daily Activities

Date 23 November 1982 (Tuesday) Log Recorded By Rick Belan

Project Hill AFB IRP Phase II Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan (Radian); Royal Taylor, Arlynd Himdal (CDI); Keith Davis (Hill AFB CE); Wayne Sugamoto (Hill AFB GC); Bill Taylor (Hill AFB CE); Claron Mackelprang (UURI)

Time (Military)	Activity or Event
1200	At Monitor Well M-6/ M-7 drillers not present. The equipment looks ready to move.
1230	Finished looking at a hillside sample excavation and geology at the base of the golf course bluff, took a geologic sample.
1245	Called CDI and spoke with Farrell Peterson and he noted that the rig, truck and water truck were frozen up. He said if they can't get them running in about an hour for Royal and Arlynd to come in for the day and bring in the flat bed truck. We discussed his second invoice and finalized activities.
1400	Drillers to stop for the day per instructions from Farrell. They got the rig and truck running and had moved equipment down to Monitor Well M-10. Farrell Peterson said they might work Friday.
1420	Went by and spoke with Wayne Sugamoto about the golf course grounds.
1445	Back at base civil engineers and spoke about project. Working on field activities, summations, and change of custody forms. Coordinated to have base civil engineer to view drilling operations of Monitor Well M-10 and soil sampling.
1715	Took instructions and soil sample bottles to CDI dog-house.
1730	Break.
2000	Working up data and information for Wednesday work meeting between Base Bioengineer, and Civil Engineer with UBTL, UURI, and Radian representatives.
2300	End of day's activities.

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RADIAN
CORPORATION

Sheet 1 of 1

Log of Daily Activities

Date 24 November 1982 (Wednesday) Log Recorded By Rick Belan

Project Hill AFB IRP Phase II Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan (Radian); LTC. Maynard Moody (Bioengineer); Dr. Sim Lessley (UBTL), Robert Vandervort (Radian); Bill Taylor, Jim Vining, Nathan Currier (Hill AFB Civil Engineers)

Time (Military)	Activity or Event
0900	Met Robert at bioengineers for meeting with UBTL, UURI, Bioengineer and Civil engineer.
∿0930	Dr. S. Lessley and Dr. H. Ross arrive we begin discussing project.
1000	LTC. Moody Jim Vinning and Nathan Currier arrive for the meeting. Radian, UBTL, and UURI provide a project background and status briefing to base personnel. A recommendation provided by Rick Belan is to emplace a well at the golf course area as we have no knowledge of the hydrogeology there and its relationship to the landfill areas particularly for recharge. No objections were made for a golf course well.
1200	End of meeting, break. Rick Belan departs for personal trip to Austin, Texas for Thanksgiving holiday weekend.
1330	Working on administrative items, also remedial measures clay cap/monitor well consideratins at Landfill No. 4 area.
1630	End of day's activities.

RADIAN CORPORATION

Sheet 1 of 1

Log of Daily Activities

Date 25/26 November 1982 (Thursday/Friday)

Log Recorded By Rick Belan

Project Hill AFB IRP Phase II

Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Bill Taylor (Civil Engineers); Farrell Peterson, Royal Taylor (CDI)

Time (Military)	Activity or Event
11/25/82	Thanksgiving Holiday.
11/26/82	Thanksgiving Holiday (Radian).
~1615	I called Hill AFB Civil Engineers and coordinated with Bill Taylor about CDI activities. He noted that Farrell Peterson decided to work today starting on Monitor Well M-10. Bill picked up two soil samples collected by CDI and took them to the Bioengineers for storage and pick-up by UBTL. (NOTE: Farrell Peterson had noted to Rick Belan early in the week that he had prior committments for Friday and probably would not work that day. In anticipation that he might work, I provided a list and coordinated with him for limited Monitor Well M-10 activities. I also obtained Base Civil Engineer assistance from Bill Taylor to check on CDI activities if they worked.)

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RADIAN CORPORATION

Log of Daily Activities

Date 27 November 1982 (Monday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Salt Lake City, Utah
Personnel on Site Rick Belan, Robert Vandervort, Clive Mecham (Radian)

Time (Military)	Activity or Event
0700	Depart Austin to Salt Lake City after Thanksgiving Holiday to resume Hill AFB field activities.
0900	Work up project information and data, and planning weeks activities.
1115	Break, arrive Salt Lake City.
1215	Coordinating with Clive on lysimeters, soil augering and field activities.
1300	Spoke with Robert Vandervort on drilling invoices and vouchers.
~1330	Called and coordinated with CDI on drilling activities.
~1400	Called U.S. Army Corps of Engineers Mel Howell in California for soil boring information around Berman Pond. He will send what boring information he has.
1630	End of day's activities.

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RADIAN CORPORATION

Log of Daily Activities

Date 30 November 1982 (Tuesday) Log Recorded By Rick Belan

Project Hill AFB IRP Phase II Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan (Radian); Farrell Peterson, Ed Hitt, Royal Taylor (CDI); Mike Trimeloni (Hill AFB CE).

Time (Military)	Activity or Event
0800	Prepare for day's activities. I don't feel well.
0900	At Base Civil Engineers picked up field gear. Bill Taylor showed me an old photo of Berman Pond which I requested. The pond was bigger than my previous information indicated.
0915	Called CDI. Farrell Peterson said it is raining right now and won't be out at this time (welding safety). He'll see around 11:00 a.m. It is raining this morning at Hill AFB.
0930	I spoke with Bill Taylor, he has the golf course base well drilling permit and Friday's chain of custody form.
1115	Called CDI and they are on their way out to Hill AFB to resume working.
1245	CDI getting ready to sep up on Monitor Well M-3 and have completed Monitor Well M-10. CDI drill rig got stuck. CDI attempted to get the rig out in the vicinity of Monitor Well M-3. The rains have softened the clayey ground.
1410	I called Mike at Base Civil Engineers for assistance to unstick the rig.
1440	Mike noted he hasn't located anyone yet to help move the rig. We will check with Keith Davis when he gets back.
1440	Spoke with Farrell who has been waiting about ½ hour. He could not do any more today and would be back Wednesday with materials to get the rig out.
1500	Went to the Base Civil Engineers to coordinate and pick up materials. Arranged for communications people to view and approve the golf course well site on Thursday. Have not been able to reach water line office all day to also approve golf course monitoring well site. Will help on Wednesday to get ahold of water line people.
1600	Break.

RADIAN CORPORATION

Log of Daily Activities

Date 30 November 1982 (Tuesday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian); Farrell Peterson, Ed Hitt, Royal Taylor (CDI); Mike Trimeloni (Hill AFB CE)

Time (Military)	Activity or Event
1645	Called Robert Vandervort to coordinate activities. Briefed him on drilling progress and discussed using a hollow stem auger for soil sampling and lysimeter emplacement. Also coordinated with Clive Mecham (Radian) on lysimeters ordered.
1800	Begin working up data and planning drilling activities and soil collection activities. Worked up monthly report input to UBTL.
2400	End of day's activities.

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CORPORATION

Sheet 1 of 1

Log of Daily Activities

Date 1 December 1982 (Wednesday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian); Keith Davis, Mike Trimeloni

Time (Military)	Activity or Event
0830	At Base Civil Engineers. There is a snow storm in progress since yesterday. Coordinating on field activities.
0900	Spoke with Keith Davis on base equipment available to help pull out CDI drill rig. Spoke with Sgt. Smith (@ 2929 or 2928) and they have a big front loader that can help. Mike Trimeloni is going to coordinate for the water line people to examine golf course well site and Berman Pond wells for 8:00 a.m. Thursday.
0925	Called CDI and spoke with Farrell Peterson because of the snow storm he won't be out. He figured that he will be out Thursday about 10:00 a.m. and get the rig out then move to Berman Pond. I went and briefed Sgt. Smith that we will be working at the rig site Thursday.
1030	Went to the Salt Lake Radian office. Coordinating with Clive Mecham on soil sampling activities.
1130	Called Larry French (Radian) to coordinate "slump" feature information for Chemical Disposal Pit No. 3 area.
~1149	Called Dr. Sim Lessley (UBTL) to coordinate activities. Sim mentioned that next week Dr. Dee Ann Sanders may be passing through this area about Thursday. She would like to meet and be briefed on the project.
1235	Called Ed Fleming (Earth Exploration and Drilling) and to coordinate up for hollow stem auger activities for next Friday at Hill AFB. He was sick so I left a message with his secretary.
~1430	Rick completed monthly report to UBTL. Very sick, end of day's activities.

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RADIAN CORPORATION

Log of Daily Activities

Date 2 December 1982 (Thursday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian); Farrell Peterson, Royal Taylor, Ed Hitt (CDI)

Time (Military)	Activity or Event
0800	Went to the Base golf course maintenance building to meet the water line and communicates people. No one there.
0825	Called communications shop and Al Simmons will be coming out. Called Mike Trimeloni about water line people.
0830	Al Simmons arrived. He used a line detector and noted my staked location was okay. This is very close to their line just east, he said if I move it west we should be OK. Also, if we do not the line it is an old one and will not cause a problem.
∿0840	Mike Trimeloni called said the water line people were on their way out.
0845	Went to Berman Pond with Al Simmons to restake monitor well. He said it looks OK and showed me generally where his lines ran.
0925	Called CDI ... Farrell Peterson will be out today, he would like the front loader about 11:30 a.m. am to help move the rig out of the mud.
0930	No water line people out yet. From golf course maintenance building, I called Mike Trimeloni for assistance. He called back and the supervisor said he would take care of it. Also spoke with Keith Davis to arrange for the front loader and chains to help move the CDI rig ∿11:30 a.m.
0940	Water like people came out and my present stakes are OK. Ended stake check ∿1010.
1015	Went to Civil Engineers and Keith Davis noted a base front loader will be available 12:30 a.m. and not 11:30.
1045	CDI on-site by Monitor Well M-3 and beginning to prepare to set up the rig to move.
1130	Called Ed Fleming of Earth Exploration and Drilling to coordinate hollow steam augering activities.

RADIAN CORPORATION

Sheet 2 of 2

Log of Daily Activities

Date 2 December 1982 (Thursday)   Log Recorded By Rick Belan
Project Hill AFB IRP Phase II   Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian); Farrell Peterson, Royal Taylor, Ed Hitt (CDI)

Time (Military)	Activity or Event
1140	Called Clive Mecham and relayed my talk with Ed Fleming.
1141	Front loader is on the way out to Monitor Well M-3 area to move CDI rig.
1200	Front loader at site and pulled out the CDI rig. Now setting up rig on Monitor Well M-3 site. Drillers worked at M-3 rest of the day drilled.
1645	End of drilling activities, took soil samples to Bio-engineer, worked up day's activities and coordination calls.
1730	End of day's activities.

RADIAN CORPORATION

Sheet 1 of 2

Log of Daily Activities

Date 3 December 1982 (Friday) Log Recorded By Rick Belan
Project Hill AFB IRP Phase II Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian); Royal Taylor, Ed Hitt, Farrell Peterson (CDI)

Time (Military)	Activity or Event
0800	Begin day's activities, preparing for continuing work on Monitor Well M-3 and project coordination calls.
0915	Called CDI to coordinate activities with Farrell Peterson.
0930	Called Clive Mecham (Radian) and coordinated field activities.
0945	Called Dr. S. Lessley (UBTL) and coordinated field activities and requested water containers for next Wednesday. Dr. Dee Ann Sanders (Brodus AFB) will not be able to make it next week to Hill AFB for a project briefing.
0955	Called Dr. Howard Ross (UURI) and coordinate field activities, and my need for several alternate resistivity survey transects to fill in some data gaps.
1045	CDI on-site and resume drilling activities at Monitor Well M-3. Rick Belan monitored drilling activities, and briefed Ed Hitt on field safety program and personnel equipment.
~1230	Went to Berman Pond area to talk with UURI and provide field information.
1310	Finished talking with Claron Mackelprang (UURI). Departed for Monitor Well M-10 to take water level and sounding measurements.
1355	Back Monitor Well M-3 where CDI is working. Drilling is hard and formation keeps caving.
1455	CDI rig hydraulic hose broke, they stop operations to repair hose. They are also getting ready to add the next 8-inch formation protective casing.
1545	Went to Monitor Well M-7 to sound, and static water level and well measurements.

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CORPORATION

Sheet 2 of 2

Log of Daily Activities

Date 3 December 1982 (Friday)　　Log Recorded By Rick Belan

Project Hill AFB IRP Phase II　　Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan (Radian); Royal Taylor, Ed Hitt, Farrell Peterson (CDI)

Time (Military)	Activity or Event
1629	The 8-inch casing has been welded, and CDI is resuming drilling at Monitor Well M-3.
1651	Farrell had earlier arrived at Monitor Well M-3 to conduct operations. 8-inch casing set to 39 feet about 7 feet below top of clay at 32 feet. Farrell and crew washing down drill pipe and rig. End of days drilling activities - open casing and hole to 49 feet below ground level.
1715	End of day's activities.

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RADIAN CORPORATION

Sheet 1 of 1

Log of Daily Activities

Date 4 December 1982 (Saturday) Log Recorded By Rick Belan
Project Hill AFB IRP Phase II Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian); Farrell Peterson, Royal Taylor, Ed Hitt, Morgan Peterson (CDI)

Time (Military)	Activity or Event
0700	Begin working on day's activities., Working up golf course well depth estimate. Work up well development activities and equipment. Drillers said they will be at site (M-3) about 9:00 a.m. for start-up probably won't be around until 10:00 a.m. ready to drill. No soil samples will be taken for analysis based upon present field data, we are not expected to be in the influence of the waste disposal area.
~0930	CDI on site at Monitor Well M-3 and resuming drilling operations. Down to ~60 feet (~10:15) and still in clay with silt and very fine sand returns.
1055	Rick Belan briefed Morgan field site safety, bailer sanitation and wearing of protective clothing while assisting in development bailing at Monitor Wells M-2, M-4 and M-9 today. Today is cold and sunny.
1130	Down to 92 feet below ground level and Farrell notes still in a clay but with small water production. Rick said lets go ahead and air lift test the formation after shut down period. So far no apparent signs of contamination. I decided to let the well stand for the weekend to take measurement and make up well completion data about Monday.
1300	CDI breaking rig down to move to drill golf course well, whole Monitor Well M-3 sits for the weekend.
1420	Morgan is about done bailing Monitor Well M-9, he has to leave today at about 1500.
1425	CDF drilling to golf course location. CDF equipment handling and water truck is stuck down slope of well location.
1520	CDI drilled open hole all in clay to 27 feet below ground level. Farrell will drive 20 feet of 6-inch casing then call it a day.
1530	End of day's activities.

RADIAN CORPORATION

Sheet 1 of 3

Log of Daily Activities

Date 6 December 1982 (Monday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian); Keith Davis (Civil Engineers); Royal Taylor, Ed Hitt (CDI); Clive Mecham (Radian)

Time (Military)	Activity or Event
0800	Called Larry French (Radian) to coordinate work request for Chemical Disposal Pit 3; also spoke with W. Little.
0830	Called Clive to coordinate lysimeter activities.
0840	Called CDI, spoke with Farrell, they are on their way up there. They could use front loader as soon as they get there to help unstick their water truck.
0845	Called Keith Davis to coordinate front loader for moving CDI water truck.
0930	At Keith Davis' to coordinate use of front loader. He indicated it would be out about 10:00 a.m.
0945	At golf course well. CDI on-site and have worked out the water truck, therefore, won't need the front loader.
0955	Called Keith Davis to cancel the front loader.
1005	Returned a call from Farrell Peterson. He wanted to know my completion plans for Monitor Well M-3. I noted I would have that information later today.
1015	Went to Monitor Well M-3 to take static water levels and sound for well completion planning.
1115	Back at new Well GC-1. The CDI welder had frozen up so had to warm it up. Ready to weld next 6-inch casing.
1215	Clive arrived on site. I briefed him on activities and we went to get equipment at Base Civil Engineers and Bioengineer's. I then took him to Berman Pond for starting the first lysimeter. Worked up M-3 completion plan to relay to CDI.
1200	Drilling activities continue at GC-1. Driller still encountering clay.

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Log of Daily Activities

Date 6 December 1982 (Monday) Log Recorded By Rick Belan
Project Hill AFB IRP Phase II Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian); Keith Davis (Civil Engineers); Royal Taylor, Ed Hitt (CDI); Clive Mecham (Radian)

Time (Military)	Activity or Event
1430	Called Dr. Sim Lessley (UBTL) and briefed him on status of Monitor Wells M-2, M-3, M-4, M-9 and GC-1. I noted that UURI was out at Chemical Disposal Pits No. 1 and 2 conducting their resistivity surveys. Dr. H. Ross (UURI) noted that they have several more hours of data modeling to do for Chemical Disposal Pit No. 3. I hoped they would completely finish out Chemical Disposal Pit No. 3 before moving to other areas and had previously talked with Dr. Ross on this. I told Sim that today we are also beginning to emplace several lysimeters.
1455	Back at Well GC-1. Drillers having problems with air rotary rig, the hammer-box jumped the guide.
1505	Called CDI. Farrell Peterson not in the office yet.
1520	Returned to Berman Pond to assist in lysimeter hand emplacement with Clive.
1545	CDI drillers Royal Taylor and Ed Hitt stopped by and told me that rig was broken down and would not be back until Tuesday. One of the hammer guides broke. Had drilled to about 42 feet today, still in a clay-red hard and dry. I continued working on lysimeter emplacement of Berman Pond with Clive Mecham.
1630	Completed lysimeter 1 at Berman Pond @ 12½ feet and also collected two soil samples from 5 and 12½feet. No obvious signs of contamination. Moved to Chemical Pit No. 3 to emplace a shallow lysimeter at corehole location CP3-13.
1640	Cleaning up and took soil samples to Bioengineers refrigreator.
1830	Completed emplacing first lysimeter at Chemical Disposal Pit No. 3 (CP3L-1).
1840	Radian field truck would not start. Went in my vehicle with Clive to get jumper cables and flashlight.

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Sheet 3 of 3

Log of Daily Activities

Date 6 December 1982 (Monday) Log Recorded By Rick Belan

Project Hill AFB IRP Phase II Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan (Radian); Keith Davis (Civil Engineers); Royal Taylor, Ed Hitt (CDI); Clive Mecham (Radian)

Time (Military)	Activity or Event
1915	Returned to Chemical Disposal Pit No. 3. Truck started up OK with a jump. Took field gear to Civil Engineers to drop off for the night.
2000	End of day's field activities. Break.
2045	Working up field data and planning field activities.
2200	End of day's activities.

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RADIAN CORPORATION

Sheet 1 of 2

Log of Daily Activities

Date 7 December 1982 (Tuesday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian), LTC. Maynard Moody (Bioengineer)

Time (Military)	Activity or Event
0745	Begin work on administrative items and field planning. Snowing this morning.
0830	Received a call from Dr. S. Lessley (UBTL) and he noted Jim Cochran will not be available next Monday and Tuesday for ground water sampling but another individual will. We discussed field equipment requirements.
0905	Called CDI to coordinate activities. They are on their way out (R. Taylor and Ed Hitt). Farrell Peterson will be out later. I left a message for him on the completion of Monitor Well M-3.
0910	Working up the other wells to sample and suitability selection went to Hill AFB.
1030	Radio noted a weather watch for snow storm and freeze.
1100	At GC-1 no drillers yet. Called CDI spoke with Karen they had a car breakdwon by Layton, Utah. Farrell Peterson went out to repair it. She indicated they will probably shut down field work due to snow storm. (NOTE: snow and winds increasing.)
1100	Called Robert Vandervort (Radian SLC), he said I need to call Larry French (Radian). Robert and I discussed M-3, GC-1, clay cap consideration and I need to talk with UURI on the project.
1200	Begin to field inspect older wells for potential sampling W-6, W-7, W-8, W-9 and W-14 per our proposal.
1430	Finished field check of old W series wells stopped into Bioengineer and briefed LTC Moody. Went to Base Civil Engineers to work, briefed Keith Davis and Bill Taylor on project status.

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Log of Daily Activities

Date 7 December 1982 (Tuesday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian), LTC. Maynard Moody (Bioengineer)

Time (Military)	Activity or Event
1500	Called Dr. Sim Lessley (UBTL) to discuss items - sampling or not to sample monitor wells W-7, W-8, W-9, W-6, and W-14; need more (14) soil sample bottles; next M-well will be Chemical Pit 3 after GC-1; Jim Cochran (UBTL) to bring 2-5 gallon jugs distilled water and meet at 9:00 am Bldg. 5; discussed moving several resistivity survey transects in Landfill No. 3/Chemical Disposal Pits Nos. 1 and 2, area to fill in what the clay is doing; I'll write a note about a landfill protection clay cap considerations.
1530	Called Jim Cochran (UBTL) and relayed we will meet 9:00 a.m. Bldg. 15 Weneesday, bring 4-5 water sample containers and for Friday need 14 soil sample bottles.
1540	Called Clive Mecham (Radian) and left message to meet at Bldg. 14, 9:00 a.m. Wednesday.
1605	Called and spoke with Dr. Sim Lessley on project.
1615	Got a call from Dr. Howard Ross and he will conduct two transects as requested, and, on Chemical Project Pit. No. 3 recommendations on Thursday.
1635	Continued working on field plans.
1730	Break.
1830	Working up barrel requirements for monitor well discharge to give to Civil Engineer for barrel request. Checked out pH and conductivity meters. Replaced batteries and adjusted meters.
2100	End of day's activities.

RADIAN CORPORATION

Log of Daily Activities

Date 8 December 1982 (Wednesday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian); Bill Taylor (Civil Engineers) Ed Royal Taylor (CDI)

Time (Military)	Activity or Event
0800	Called UBTL and Radian (SLC) to not come out to base due to extreme winter weather conditions and winds (Arctic style).
0840	Called CDI to check on their work status today. They will probably not work today due to weather, but if any change, he'll (FP) call Keith Davis and leave word for me.
0900	Working up field activities.
1000	At Base Civil Engineers to coordinate activities.
1045	Called communications to get up for Berman Pond stake clearance for Friday's hollow stem augering meeting and Building. I spoke with Al Simmons. I checked with Bill Taylor on coordinating with water line people to check Berman Pond also, I could not get them on the phone.
1100	Went to Berman Pond to stake out next soil sample and lysimeter locations for hollow stem augering Friday.
1300	Called CDI. Farrell Peterson said they'll come o t to give it a try but if too cold they'll go back in. I noted its still very windy and cold but might be workable. I then went to Well GC-1.
1240	Saw water line people on base to check out lysimeter stakes at Berman Pond. I said I'll meet them out there at Berman Pond.
1250	Called base snow control. They did what they could to clear snow at the golf course, but will have to wait until swing shift to get a snow blower out at Well GC-1. The access road to the site is mostly snow covered. (Snow Control 62928/9)
1255	Called CDI to relay that golf course road access is limited. He noted they were going to try and still drill.
1305	Went to Berman Pond to get with Doug of water lines. Saw CDI going to site talked with them briefly.

RADIAN CORPORATION

Log of Daily Activities

Date 8 December 1982 (Wednesday) Log Recorded By Rick Belan

Project Hill AFB IRP Phase II Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan (Radian); Bill Taylor (Civil Engineers); Ed Hitt, Royal Taylor (CDI)

Time (Military)	Activity or Event
1330	Completed water line check for hollow stem augering on Friday. My staked locations are OK.
1335	Called Radian and UBTL to relay no ground water supply activities this afternoon. Spoke with Dr. Sim Lessley and requested Jim Cochran to be at 9:00 a.m. Thursday Building 15.
1400	Went to Well GC-1 Royal Taylor and Ed Hitt on-site the rig access is bad (snow drifts). Rig is drifted in, and extreme cold winds make working extremely difficult. They picked up some drilling equipment to take back to the shop. They will not be working the rest of the day.
1430	Working up field data and notes and planning monitor well sampling activities; still extremely cold and windy.
1630	End of day's activities.

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Sheet 1 of 2

Log of Daily Activities

Date 9 December 1982 (Thursday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan, Clive Mecham (Radian); Jim Cochran (UBTL); Ed Hitt, Royal Taylor, Farrell Peterson (CDI)

Time (Military)	Activity or Event
0730	Begin field activities, today we plan to be at Well GC-1 to continue to drill, and ground water sampling activities. Also checking out soil auger hole versus utilities locations. The weather is cold but not as windy as yesterday.
0815	I called base communications and they will be out to check my auger hole location at Berman Pond.
0817	Mr. Douglas came out to Berman Pond and all stakes looked OK for augering Friday. He noted when they were working around Bldg. 555 sometime ago there was a strong odor inside the building.
0825	Went to Well GC-1 to check out weather conditions - still cold, not quite as windy.
0845	Called CDI. I told Farrell Peterson that it was still cold but not as windy, road is open to rig. He said that they'll be out around 10:00 a.m. and see how far they can get in view of the weather.
0910	Back at Civil Engineer's and Clive Mecham is in the office. I briefed him on the day's activities and measurements needed and his bailing assistance with Jim Cochran.
0945	Called Dr. Sim Lessley (UBTL) and briefed on field activities.
∿ 1000	J. Cochran arrived; we went to M-4 and after briefing him, begin ground-water sampling.
∿ 1100	CDI on-site begin to warm up rig engines.
1130	Begin bailing to sample at M-4.
1140	Saw UURI on base.
1230	CDI got rig and equipment warmed up and continued to drill at golf course Well GC-1. Broke out of clay at 50 ft. into a sand (VF).
1240	CDI rig pull down chain broke and need to repair. Royal Taylor and Ed Hitt make preparations to repair rig.

RADIAN CORPORATION

Sheet 2 of 2

Log of Daily Activities

Date 9 December 1982 (Thursday) Log Recorded By Rick Belan

Project Hill AFB IRP Phase II Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan, Clive Mecham (Radian); Jim Cochran (UBTL); Ed Hitt, Royal Taylor, Farrell Peterson (CDI)

Time (Military)	Activity or Event
~1300	Clive Mecham and Jim Cochran came to inform me that the monitor well bailer broke. I went with them to retrieve it. They continued bailing/sampling activities the rest of the afternoon.
~1320	Bailer fishing successful went back to golf course well. Ed and Royal were in the golf course maintenance building using equipment to repair the drill rig chain. Farrell Peterson came on-site to view operation.
1430	CFI repairs done, resume drilling activities.
1640	CDI hammer broke, will repair tomorrow.
~1700	Called Robert Vandervort and discussed field progress.
1830	End of day's activities.

RADIAN CORPORATION

Log of Daily Activities

Date 10 December 1982 (Friday)   Log Recorded By Rick Belan

Project Hill AFB IRP Phase II   Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan (Radian); Dave Moffitt, Ed Fleming (Earth Exploration & Drilling); Gordon Allcott, Clive Mecham (Radian); Claron Mackelprang (UURI)

Time (Military)	Activity or Event
0730	Begin field activities, preparing for a variety of field tasks.
0800	Picked up field gear at base Civil Engineer's.
0815	Called Dr. Sim Lessley (UBTL), briefed him on activities of golf course well, GC/S screen from GC-1, resistivity surveying at the golf course, ground water complete analysis for selected well, Clive Mecham coming by to pick up sample containers. Sim not in so I left a message.
0830	Called UURI, Dr. Howard Ross not in.
0900	Dave Moffitt and Ed Fleming of Earth Exploration and Drilling (EE&D) begin hollow-stem augering at Berman Pond. Rick briefed drillers on project safety then began directing drilling efforts. They are using a hollow-stem auger rig to help get soil samples and lysimeter emplacement.
1000	Gordon and Clive arrive to begin field work. Gordon will be assisting me in bailing development while Clive will be monitoring the hollow-stem augering activities at Berman Pond.
1015	UURI came by and Rick briefed Claren on the need for a golf course resistivity survey.
1120	EE&D moves to next auger hole at Berman Pond.
1135	Called UBTL. Spoke with Dr. Sim Lessley, we discussed project. Rick Belan is to provide recommendations for Well GC-1 and any others this weekend.
1200	At Berman Pond monitoring augering activities. Briefed Clive and went to see Gordon.
1300	At M-1.
1400	At Well GC-1 the casing is cleaned out of clay, I measured the static water level and sounded. It's OK to complete with stainless steel screen.

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Log of Daily Activities

Date 10 December 1982 (Friday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian); Dave Moffitt, Ed Fleming (Earth Exploration & Drilling); Gordon Allcott, Clive Mecham (Radian); Claren Mackelprang (UURI)

Time (Military)	Activity or Event
1640	Finished hollow-stem augering of CP3-6 (A) & (B) at Chemical Disposal Pit No. 3. Clive and Gordon work end of day. Rick will finish out.
1645	EE&D setting up on CP3-15 (new hole) at Chemical Disposal Pit No. 3. Clive Mecham and Gordon Allcott depart for the day.
1740	Completed hollow-stem auger activities, release Earth Exploration & Drilling crew.
1755	Took 13 soil samples collected today and placed in Bio-engineer freezer. Building door secure when I left.
1815	Went by Bldg. 15 Base Civil Engineer's to pick up a message on field work summary from Gordon Allcott.
1830	Departed base for the day.
1930	Working on day's activities data and notes.
2020	Called Gordon and rearranged for him to come out earlier than UBTL for bailing wells so as to be closer to sampling when UBTL arrives.
2100	End of day's activities.

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RADIAN CORPORATION

Sheet 1 of 1

Log of Daily Activities

Date 11 December 1982 (Saturday)

Log Recorded By Rick Belan

Project Hill AFB IRP Phase II

Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan, Clive Mecham (Radian)

Time (Military)	Activity or Event
0900	At Well GC-1 drillers not on-site yet. They indicated they would be working today.
0915	Went to Bldg. 15 Civil Engineer's to begin lysimeter emplacement activities. Arranged to clear Clive Mecham and I access to our equipment.
1000	Clive Mecham arrives, we discuss lysimeter emplacement and construction. We begin constructing lysimeters using the previously drilled auger holes.
1045	Went to Well GC-1 and CDI drillers not on-site yet.
1115	Begin helping Clive to emplace lysimeters after checking vacuum pump out at Monitor Well M-3. The vacuum pump did not work as the static water level was too deep. Therefore, because the monitor wells are such low producers we'll have to continue with bailing for sampling.
1425	Finished lysimeters at Berman Pond. Checked on CDI drillers, not at site. Moved to Chemical Disposal Pit No. 3 to emplace a lysimeter and plug one auger hol.e
1730	Clive departed for the day and placed field gear in Bldg. 15. Rick finished washing hand-augere sampling equipment.
1800	All field gear placed into Bldg. 15. End of day's activities. Drillers did not come on-site today to my knowledge as they indicated yesterday they probably would.
1900	Called Dr. Sim Lessley and coordinated project information: budget is set up for 7 screens, we'll do mass spec. and GC screen on Monitor Wells M-2, M-6. He'll set up sampling for Monitor Wells M-7 and M-8 for Tuesday.

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Log of Daily Activities

Date 13 December 1982 (Monday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian)

Time (Military)	Activity or Event
0745	Snow storm. Called UBTL and left message for Dr. Sim Lessley and Jim Cochran not to come out this morning at Hill AFB as no activities due to snow storm and slick roads. Called Radian - Gordon Allcott and same message.
0900	At Base Civil Engineer's coordinating activities.
0915	Called CDI returned call from Farrell Peterson (CDI). Farrell is at St. George, Utah and will not be in until Tuesday. I spoke with Royal Taylor (CDI); they will not be out until Tuesday. Farrell can be reached at 1-(800)673-9897, but has already left.
0925	Called UBTL spoke with Dr. Sim Lessley. Discussed ground water parameters for GC-1, M-6, M-10, M-3, and opt. M-7, M-2, M-9. We discussed "trich. pit" alternatives from the complexity of the geology we may want to consider alternatives to a well if to have one at all. He'll appraise Dr. Dee Ann Sanders (Brooks AFB) of problem with Trich Pit and that possible other recommendations may be coming. Also briefed Sim on small volumes expected from lysimeters, he said he can taylor analysis. Phone conversation ended approx. 1030.
1035	Working on project and field equipment cleaning and repair.
1145	Called Robert Vandervort Radian (SLC) discussed my landfill No. 4 clay cap consideration letter for possibility that it may not be desirable to construct an expensive monitor well at Landfill No. 3 which is also conceptually planned to have a clay cap. It will be best to wait until all of UURI survey info. is in at Chemical Pit 3 before emplacing an air rotary well there. End 1240.
1245	Called Earth Exploration and Drilling (EE&D) and spoke with Ed Flemming and discussed their monitor well installation experience using hollow-stem augers.

RADIAN CORPORATION

Sheet 2 of 2

Log of Daily Activities

Date 13 December 1982 (Monday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian)

Time (Military)	Activity or Event
1310	Called UURI and spoke with Dr. Howard Ross and he noted they are approx. 80% done with Chem. Pit 3. I requested an M.S. Thesis inform. on slump features across the valley that was done by one of his team members. We discussed augering at Chem. Pit No. 3. I noted that due to the uncertainties at Chem. Pit No. 3 hollow-stem augering and piezometer emplacement would provide us with much more information where we don't have any right now. He feels that this sounds good. I noted this will provide us a higher confidence level for determining the depth and/or need for an expensive monitor well. End approx. 1345.
1345	Working on field gear and project data planning.
1630	End of day's activities.

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Sheet 1 of 2

Log of Daily Activities

Date 14 December 1982 (Tuesday) Log Recorded By Rick Belan
Project Hill AFB IRP Phase II Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian); Royal Taylor, Farrell Peterson, Ed Hitt (CDI); Gordon Allcott (Radian)

Time (Military)	Activity or Event
0800	Working up soil sample inventories and tallies for transfer to UBTL. Working on coordination and day's activities.
0917	Called CDI, they will work, and Farrell Peterson will be out around noon. He is not in town yet.
0929	Called UURI and spoke with Dr. Howard Ross and noted to him that I feel that hollow-stem augering before we drill a well would be in order. He agreed. I asked him to select 3 or 4 locations at Chemical Disposal Pit No. 3 that will be useful to him in his geophysics analysis. We'll need to talk to Dr. Sim Lessley (UBTL) today to apprise him.
1000	Conducted sample inventory at Bioengineer's and arranged for sample transfer to UBTL this afternoon.
1016	CDI on-site at Well GC-1 (Ed Hitt and Royal Taylor). They had pulled out drill steel. Rick makes a sounding and static water level check to be sure the well is OK. Also, bailed to insure hydraulic communication with the formation. Approx. 1 1/2 hrs. standby time.
1145	Called CDI to return Farrell Peterson's call. He's not in yet.
1200	I and Gordon Allcott can't get good bailing returns from Well GC-1 and my measurements indicate the screen may be stuck right about static water level. Emplaced ∿5 gallons of water and ∿1/3 cup drill foam to loosen any compacted formative sands, but still no good ground water returns.
1330	Farrell Peterson (CDI) arrives on-site. He told Ed and Royal to put the drilling rig back over the well. (They had broken rig down earlier today.)
1345	Rig is set up, Farrell Petdrson will try to air develop screen.
1445	Gordon Alloctt and Jim Cocheran stopped by from bailing Monitor Well M-1. They noted the water smelled but not strong.

RADIAN CORPORATION

Log of Daily Activities

Date 14 December 1982 (Tuesday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian); Royal Taylor, Farrell Peterson, Ed Hitt (CDI); Gordon Allcott (Radian)

Time (Military)	Activity or Event
1450	Well GC-1 isn't developing, and the screen will not go down to the target level. Rick and Farrell discuss the well, Farrell will pull the screen then clean out the casing to reinsert the screen.
1455	Farrell begins screen pulling operations using a "basket and gravel" method. CDI having problems securing the screen and work the rest of the afternoon.
1730	End of day's activities. CDI departs for the day.

RADIAN CORPORATION

Sheet 1 of 2

Log of Daily Activities

Date 15 December 1982 (Wednesday) Log Recorded By Rick Belan
Project Hill AFB IRP Phase II Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian); Farrell Peterson, Royal Taylor, Ed Hitt (CDI); Gordon Allcott (Radian); Jim Cochran (UBTL)

Time (Military)	Activity or Event
0740	Called Gordon Allcott (Radian) and Jim Cochran (UBTL) to coordinate activities as we are having a snow storm. Gordon will come out about 1000 and Jim Cochran about 1300 as planned for monitor well sampling.
0800	Called Larry French (Radian) to relay field status and need assistance for a report evaluation.
0840	Called CDI, Farrell Peterson said he'll try to pull screen by several other methods and if not successful he'll pull the 6-inch casing then move over and quickly drill another well.
0950	Called UBTL Dr. Sim Lessley not in so I left a message.
1105	CDI arrived on-site at Well GC-1. They begin working on the well to retrieve the screen.
1130	Called EE&D for their auger information.
1230	Farrell Peterson noted he can't get the screen out. He will pull out and move forward to drill another well. He said it would be cheaper than to keep trying to "fish" at this well. I said I'd rather not leave an incomplete well and suggested he try to retrive the screen for one more hour. I suggested a modification to his retrieval basket system.
1305	CDI retrieved Well GC-1's stainless steel screen. The screen is slightly deformed but OK and functional.
1335	Rick makes sounding and static water level measurements at Well GC-1. The reason the screen got stuck was due to the very fine formation sand heaving up into the casing. I discussed the heaving sand with Farrell Peterson and decided not to set a stainless steel screen in Well GC-1.
1430	CDI completed cleaning out Well GC-1 and break down to move the equipment to Berman Pond. Rick makes final well measurements.
1530	Spoke with Gordon about their monitor well activities.

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CORPORATION

Sheet 2 of 2

Log of Daily Activities

Date 15 December 1982 (Wednesday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian); Farrell Peterson, Royal Taylor, Ed Hitt (CDI); Gordon Allcott (Radian); Jim Cochran (UBTL)

Time (Military)	Activity or Event
1615	I spoke with Robert Vandervort (Radian, SLC) who called me to coordinate contract modifications. Rick Belan needs to work up costing for Well GC-1, budgetary trade-offs, Chemical Disposal Pit No. 3, hollow-stem auger investigation, and upcoming drilling activities. Robert and Rick discuss a logical holiday break would be over Christmas and New Years, because additional snow storms and very cold weather are expected, and also to let contract modifications go through channels for final disposition.
1700	Break.
2230	Worked up contract Modification and budget consideration. This centers around Well GC-1, hollow-stem augering at Chemical Disposal Pit No. 3 and extended drilling field activities due to weather and drilling problems. End of day's activities.

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Sheet 1 of 1

Log of Daily Activities

Date 16 December 1982 (Thursday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian); Farrell Peterson, Ed Hitt, Royal Taylor (CDI); Gordon Allcott (Radian)

Time (Military)	Activity or Event
0800	Begin field activities.
0900	Called and spoke with Gordon on ground water sampling efforts.
0920	Briefed LTC. Moody (Bioengineer) on past days activities at Well GC-1 and start-up at Berman Pond.
1040	CDI on-site at Berman Pond and begin drilling activities for Monitor Well No. 1 (BPM-1). Rick decided to complete the Berman Pond wells like the deep wells at Landfill No. 3 with an 8-inch protective formation casing based upon the data review conducted to date.
1220	The 8-inch casing has been drilled and driven to 29 feet below ground level. Will now resume regular drilling operations with 6-inch casing. No visible signs of any contamination.
1255	Drill pipe got stuck in the ground. Farrell Peterson works to free it.
1310	Drill pipe sticks again. Farrell works it free again but has difficulty pulling it out because of clays balling up inside the 6-inch casing.
1355	Called from Building 555, Dr. Sim Lessley (UBTL) to update and coordinate project.
1535	Went with Gordon Allcott to remove our field equipment from the Base Civil Engineer's for the holiday break and their base inspection preparation. Returned to Berman Pond drilling operations.
1605	CDI not at Berman Pond. Water truck is gone, went to fill it up. 1610 CDI returns and resume operations.
1645	CDI welding 6-inch casing then drill and drive casing to 70 feet for end of day's activities.
1800	End of day's activities.

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RADIAN CORPORATION

Log of Daily Activities

Date 17 December 1982 (Friday)

Log Recorded By Rick Belan

Project Hill AFB IRP Phase II

Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan (Radian); Farrell Peterson, Ed Hitt, Royal Taylor (CDI)

Time (Military)	Activity or Event
0730	Went to pick up monitor well temporary capping materials.
0830	Called UBTL to coordinate activities. Dr. Howard Ross will get with Dr. Sim Lessley on my requested golf course area resistivity survey. Dr. Lessley noted that Dr. D.A. Sanders (Brooks AFB) agreed to the suggested holiday field break due to winter weather and time to work through project changes.
0915	Called CDI to coordinate Monitor Well M-3 completion scenario.
0920	Called Radian office to coordinate with Robert Vandervort on project.
0950	Called Earth Exploration and Drilling to coordinate their availability to conduct augering operations at Hill AFB the first week in January.
1000	Went and briefed LTC. Maynard Moody (Bioengineer) on field work status, field break period, and on UURI resistivity survey data on Chemical Disposal Pit No. 3.
1015	At Berman Pond CDI not on-site yet.
1015	CDI on-site at Berman Pond preparing for day's activities at Monitor Well BPM-1.
1440	Reached total depth of 122 1/2 feet at Monitor Well BPM-1 distinct ground water at about 116 feet. We'll complete well now. CDI begins preparing well for completion.
1510	Rick Belan and Farrell Peterson discuss screen setting. Screen setting may be difficult due to very fine sand encountered which has been entering the casing.
1550	Working on cleaning out casing and bottom with clean water for screen setting preparations.
1645	Stainless steel screen set and CDI getting ready to pull 6-inch casing to expose screen at Monitor Well BPM-1.

RADIAN CORPORATION

Sheet 2 of 2

Log of Daily Activities

Date 17 December 1982 (Friday)

Log Recorded By Rick Belan

Project Hill AFB IRP Phase II

Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan (Radian); Farrell Peterson, Ed Hitt, Royal Taylor (CDI)

Time (Military)	Activity or Event
1720	CDI completed screen setting and cleaned out screen bottom and worked on developing the well with air. Lots of very fine material comes up.
1800	End of day's activities.

RADIAN CORPORATION

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Log of Daily Activities

Date 18 December 1982 (Saturday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian); Farrell Peterson, Ed Hitt, Royal Taylor (CDI)

Time (Military)	Activity or Event
0830	On-site to make static water level and sounding measurements at Monitor Well BPM-1 and golf course Well GC-1.
0930	CDI on-site at Berman Pond and begin development activities at Monitor Well BPM-1 per Rick's instructions.
1053	Completed development at Moniotr Well BPM-1. It's not very productive, could airlift about 1 quart per minute very fine sand still comes into casing.
1100	Begin to break rig down to move to Monitor Well BPM-2.
1200	Rick completed weathering all monitor wells except M-3.
1235	CDI set up at Monitor Well BPM-2 and we begin drill and drive operations and obtaining soil samples.
1343	Down to a depth of ∿25 feet and no visible signs of contamination. 8-inch formation protective casing in-place will now conduct regular 6-inch casing silling.
1530	CDI completes drilling activities for the day will resume drilling on Monday 12/20/82.
1545	Rick took soil samples collected to Bioengineer refrigerator. Building door secured when I left.
∿1630	End of day's activities.

RADIAN CORPORATION

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Log of Daily Activities

Date 19 December 1982 (Sunday)

Log Recorded By Rick Belan

Project Hill AFB IRP Phase II

Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan (Radian)

Time (Military)	Activity or Event
~0930	Called Mike Floyd (Radian) to coordinate project activities.

RADIAN CORPORATION

Log of Daily Activities

Date 20 December 1982 (Monday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian); Farrell Peterson, Ed Hitt, Royal Taylor (CDI); Claron Mackelprang (UURI)

Time (Military)	Activity or Event
0730	Called Ann St.Clair (Radian) to brief and coordinate field activities.
0900	Called CDI. Farrell Peterson and crew are on their way out. He plans to work on monitor well surface features and Monitor Well BPM-2.
0907	Called Tom Emmel (Radian, SLC) to coordinate activities.
0910	Called UBTL and spoke with Dr. Sim Lessley on project. We discussed Berman Pond wells, soil sample disposition, and resistivity survey at the golf course area.
0940	Called Earth Exploration and Drilling and spoke with Ed Flemming. They had not completed the final truck wash down I said was needed. The truck had not been used and will be final washed.
0953	Called UURI and spoke with Dr. Howard Ross on project.
1015	CDI on-site and preparing to resume drilling operations at Berman Pond on Monitor Well BPM-2. Water truck is not starting up due to weather, rig sets started.
1030	Met Claron Mackelprang and discussed where I want to have a golf course resistivity survey line as well as secondary lines in the Chemical Disposal Pit Nos. 1 & 2 and Landfill 3 areas.
1116	All CDI equipment ready to go. Farrell resumes drilling operations.
1255	Monitor Well BPM-2 the 6-inch casing slipped below ground level several feet. CDI working on casing retrieval. Rick went to Berman Pond Monitor Well BPM-1 to tube static water level measurements.
1345	Farrell Peterson finished retrieving the 6-inch casing and now ready to continue drilling.
1447	Begin screen setting operations at Monitor Well BPM-2 after reaching total depth with a very productive artesian aquifer.

RADIAN CORPORATION

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Log of Daily Activities

Date 20 December 1982 (Monday)

Log Recorded By Rick Belan

Project Hill AFB IRP Phase II

Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan (Radian); Farrell Peterson, Ed Hitt, Royal Taylor (CDI); Claron Mackelprang (UURI)

Time (Military)	Activity or Event
1520	Screen successfully set. Farrell Peterson blew out well and got lots of ground water. Rick destroyed the various plastic containers used by the drillers for washdown and decontamination. To date, no obvious soil or ground water contamination was observed.
1550	CDI now tearing down, end of activities at Monitor Well BPM-2. CDI washes the rig and drilling equipment down. Rick takes care of other field tasks.
1700	Making final coordinates and preparation for Tuesday departure back to Radian, Austin, Texas for weather and project break for the holidays. CDI will work on all the monitor well surface feature completion during the holiday period, weather permitting.
2100	End of day's activities.

RADIAN CORPORATION

Sheet 1 of 1

Log of Daily Activities

Date 30 December 1982 (Thursday)

Log Recorded By Rick Belan

Project Hill AFB IRP Phase II

Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site --

Time (Military)	Activity or Event
1200 (?)	I called CDI to coordinate field activities at Hill AFB and to get an update. They have gone up to the base to conduct surface casing grouting. I noted I plan to resume field operations 4 January 1983. Farrell Peterson was not in so I left a message for him.

RADIAN CORPORATION

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Log of Daily Activities

Date 4 January 1983 (Tuesday) Log Recorded By Rick Belan

Project Hill AFB IRP Phase II Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site

Time (Military)	Activity or Event
0700	Depart for Hill AFB, Utah to resume field activities. Weather delays flights.
1140	Called Ann St.Clair (Radian) to brief her on flight delays and project. Then I called Radian (SLC) office to inform them of my late arrival and rental car coordination.
1230	Called CDI for an update.
1245	Called UBTL, Dr. Sim Lessley to brief him.
1440	Called Earth Exploration and Drilling from Denver to coordinate drilling at Chemical Disposal Pit No. 3. Their equipment has been snowed in and will be ready for a Thursday start-up.
1615	Arrive Salt Lake City, check in at Radian office and pick up field gear.
1800	End of day's activities.

RADIAN CORPORATION

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Log of Daily Activities

Date 5 January 1983 (Wednesday)

Log Recorded By Rick Belan

Project Hill AFB IRP Phase II

Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan (Radian)

Time (Military)	Activity or Event
0700	Begin working on field project. Working up administrative and field tasks.
0915	At Bioengineers and spoke with Maj. Gaudet on the seeps they have been sampling at the Landfill No. 4 area.
0947	Begin monitor well completion construction inspection, inventory and lysimeter purging. Monitor wells 1) OK - BPM-2, GC-1, M-9, M-10, M-2, M-6, M-8 2) Unfinished - M-4 (not done), M-3, (lock cap not done), M-1 (not done), BPM-1 (not done). Need to coordinate with CDI on unfinished items.
1130	Finished lysimeter purging, monitor well inspection. Called Earth Exploration and Drilling, arranged to meet after 2:00 p.m. Called CDI and Farrell Peterson is in and for me to go by (SLC) and coordinate field activities.
1215	Met with CDI, Farrell and I discussed project, and picked up his invoices.
1315	At SLC office working up latest CDI invoices and coordinate activities.
1400	Called Dr. Sim Lessley to coordinate monthly report and conductivity meter check out.
1615	Called Earth Exploration and Drilling to coordinate activities.
1700	Called UURI and coordinated with Dr. Howard Ross on Chemical Disposal Pit 3 augering.
1800	End of day's activities.

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Log of Daily Activities

Date 6 January 1983 (Thursday) Log Recorded By Rick Belan

Project Hill AFB IRP Phase II Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan (Radian); Dave Moffitt and Mark Y. Barra (Earth Exploration and Drilling)

Time (Military)	Activity or Event
0850	Met Dave Moffitt and Mark of Earth Exploration and Drilling at Berman Pond to take them to Chemical Disposal Pit No. 3.
0915	Setting up for hollow-stem auger operations at Chemical Disposal Pit No. 3. Begin first augering at 0930 at auger hole No. 3 (CP3A-3).
1230	Completed (split-spoon sampling and) auger hole CP3A-3 as a piezometer (P-1) to a depth of about 22 feet, encountered ground water at about 20 feet which was screened across a sand and gravels. No obvious contaminatior noted.
1240	Moved to auger hole CP3A-4 and began drilling. I'm not feeling very good.
1510	Hit clay at ~17 feet to 35 feet no ground water yet. The clay is moist and plastic and augering is slow. We'll total depth for the day and resume on Friday, as I feel ill.
1520	The bit column drops in the hollow-flights. Dave and Mark begin to "fish" for the auger bit.
1625	All hollow-stem auger equipment is out of the auger hole.
1625	Took two soil samples to Bioengineer's for storage.
1640	End of day's activities. I'm very sick.

RADIAN CORPORATION

Sheet 1 of 1

Log of Daily Activities

Date 7 January 1983 (Friday)

Log Recorded By Rick Belan

Project Hill AFB IRP Phase II

Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site --

Time (Military)	Activity or Event
	No field work today as very sick with coughing and fever. I called Earth Exploration and Drilling and informed them to hold until Monday.

RADIAN CORPORATION

Log of Daily Activities

Date 10 January 1983 (Monday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian); Dave Moffitt and Mark Ybarra (Earth Exploration & Drilling); Gordon Allcott (Radian)

Time (Military)	Activity or Event
0910	Made a static water level measurement at piezometer P-1 (CP3A-3) and also water in auger hole CP3A-4. Dave and Toni arrive. I discuss the potential to complete a piezometer in auger hole CP3A-4.
0930	I have Dave and Mark go back in with augers to clean out hole to be sure we have a water-bearing zone. We'll have to complete a piezometer through the hollow augers instead open hole. No apparent contamination.
1100	I finished briefing Gordon on bailing activities for well developments at the other waste sites. Gordon arrived @ 1010.
1135	Dave and Mark ready to complete piezometer P-2.
1200	Two-inch PVC pipe, screen and gravel pack emplaced, but having difficulties in retrieving the auger flights.
1235	I said let's pull the pipe and screen and begin again.
1320	I called Dr. Sim Lessley (UBTL) and discussed project. I'm still not feeling very well from being sick this weekend.
1450	Back at Chemical Disposal Pit No. 3. Toni and Dave successfully completed CP3A-4, now at piezometer P-2. Begin to move to auger hole CP3A-5.
1520	Begin augering.
1630	Augered to about 27 feet hit water bearing zone(s). I have Dave and Mark pull at flight to let open hole stand overnight to make water level measurements the next morning.
1640	Took split-spoon samples to Bioengineer's for storage in refrigerator. Saw Ltc. Maynard Moody and briefed him on the field activities.
1730	End of day's activities.

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Log of Daily Activities

Date 11 January 1983 (Tuesday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian); Dave Moffitt and Mark Ebarra (Earth Exploration & Drilling); Gordon Allcott (Radian)

Time (Military)	Activity or Event
0900	Dave, Mark and Rick on-site at Chemical Disposal Pit No. 3 to continue augering activities. Rick makes a water level measurement at auger hole CP3A-5 and plans to complete a piezometer.
0945	Gordon arrives on-site and we discussed field activities.
1000	Have Dave and Mark go back in to clean out auger hole and prepare to complete a piezometer. Augered back to 29 feet, and begin completion operations.
1225	Auger flights get stuck and have to pull everything out and start again.
1410	Dave and Mark need more gravel. Ed will bring up 6 bags of cement for surface completions.
1415	Called UBTL to coordinate with Dr. Sim Lessley on present auger holes. He had spoken with Dr. D.A. Sanders (Brooks, AFB) and we can do 6 boreholes up to about $2,000 effort. We discussed Bioengineer people available to help with lysimeter sampling as now there are too many simultaneous field activities that I need assistance.
1440	Called CDI and spoke with Farrell Peterson about Monitor Well M-3 completion and the next well, if any, at Chemical Disposal Pit No. 3.
1500	Successfully completed auger hole CP3A-5 (P-3) in a sand zone, now moved forward ∿ 6 feet to complete a shallow piezometer (P-4) at ∿18 feet at 1530. No obvious contamination.
∿1630	Completed piezometer P-4 in a shallow sand zone. No obvious contamination.
∿1700	End of day's activities.

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Log of Daily Activities

Date 12 January 1983 (Wednesday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian); Dave Moffitt and Mark Ybarra (Earth Exploration and Drilling)

Time (Military)	Activity or Event
0830	At Hill AFB to continue auger activities at Chemical Disposal Pit No. 3. It's extremely cold today.
1005	Dave and Mark, on-site and prepare to move to next auger hole. Rick makes static water level measurements.
1015	Begin to split-spoon sample and auger CP3A-6. Hit a clay at ~17 1/2 feet cuttings moist but no apparent free water continue augering.
1330	Still augering in a clay at about 40 feet. Bit column separated Dave and Toni are fishing for it.
1400	Bit is recovered, resume augering and sampling operations.
1600	Still in a clay to 50 feet, split-spoon samples at about 46 and about 50 feet are wet. No obvious contamination.
1620	Have Dave and Mark pull hollow-stem auger out for the night so I can take measurements on Thursday.
1715	Took split spoon samples to Bioengineer for storage. End of day's activities.

RADIAN CORPORATION

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Log of Daily Activities

Date 13 January 1983 (Thursday)

Log Recorded By Rick Belan

Project Hill AFB IRP Phase II

Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan (Radian); Gordon Allcott (Radian); Dave Moffitt and Mark Ybarra (Earth Exploration and Drilling)

Time (Military)	Activity or Event
0745	Picked up field supplies.
1910	At Chemical Pit 3 at A-6 and A-4 to take water level measurements.
0950	Went to Base Civil Engineer to coordina and make calls.
1032	Called Earth Exploration and Drilling to coordinate activities and costing. Drillers are working on well completion items to bring out.
1045	Called UBTL and coordinated with Dr. S. Lessley.
1110	Called Radian SLC and coordinated with Robert Vandervort (Radian).
1200	Went to Chemical Disposal Pit 3 to bail completed 2-inch piezometers and await drillers.
1330	Drillers arrive and we begin activities to complete piezometer P-5 at auger hole CP3A-6 and then emplace piezometer casings. No obvious contamination.
1500	I depart Chemical Disposal Pit 3 with driller to get water for truck and make coordination calls.
1530	Joined Gordon Allcott to assist in bailing preparation of monitor wells for Friday sampling.
1730	End of day's activities.

RADIAN CORPORATION

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Log of Daily Activities

Date 14 January 1983 (Friday) Log Recorded By Rick Belan
Project Hill AFB IRP Phase II Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan and Gordon Allcott (Radian); Jim Cochran (UBTL); SSgt. D. Rollins, Sgt. K. Juma and Alo. K. Kecheisen (Hill AFB Bioengineers)

Time (Military)	Activity or Event
0805	Called CDI to coordinate with F. Peterson. Coordinated drilling activities and monitor well completion. M-3 is OK.
0820	Called Earth Exploration and Drilling to discuss billing and materials.
0830	Called UBTL to coordinate with J. Cochran on today's field activities.
0835	Called Radian (SLC) to coordinate with Gordon Allcott.
0848	Called UBTL spoke with Dr. Sim Lessley. For a Monday meeting plan 10:00 a.m. at Sim's office. Rick Belan please bring out our field conductivity reading data.
0950	Met with Bioengineer LTC Moody to arrange for lysimeter assistance. We'll meet at 2:00 p.m. at Bldg. 555 to instruct his people in getting samples from lysimeters.
1010	Met Gordon and Jim to begin next round of monitor well resampling. Today we will bail sample BPM-1, 2, W-7; resample M-1, M-2, M-4, M-9, M-7 and W-8. Also take pH, temperature and conductivity readings. Also to drill air breather holes in monitor well caps.
1145	Rick went to Bioengineers and prepared soil samples for Jim to take back to UBTL.
1400	Met SSgt. D. Rollins, Sgt. K. Jama and Alc. K. Keckeisen at Berman Pond to begin instructions into the taking of soil water samples from hte lysimeters. UBTL had requested Bioengineers assistance to take lysimeter samples. Rick and Jim (UBTL) covered sampling safety, sample extraction, handling and storage with the air force personnel.
1630	Completed lysimeter sampling and instruction for the lysimeters emplaced at Berman Pond and Chemical Disposal Pit 3. Plan to resample 1/18/83. The lysimeters provide samples ranging from maximum to nothing.

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Log of Daily Activities

Date 14 January 1983 (Friday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan and Gordon Allcott (Radian); Jim Cochran (UBTL); SSgt. D. Rollins, Sgt. K. Juma and Alo. K. Kecheisen (Hill AFB)

Time (Military)	Activity or Event
1650	Went to Chemical Disposal Pit No. 3 to bail piezometer P-5 to establish the hydraulic continuity with the formation.
1710	Completed bailing and day's activities.

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Log of Daily Activities

Date 16 January 1983 (Sunday)   Log Recorded By Rick Belan
Project Hill AFB IRP Phase II   Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site --

Time (Military)	Activity or Event
0900	Working up building activities notes and working on upcoming activities.
1100	Break.
1800	Resume bailing analytical tabulations and planning upcoming activities and making cost estimations.
2130	End of day's activities.

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Sheet 1 of 1

Log of Daily Activities

Date 17 January 1983 (Monday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Salt Lake City, Utah
Personnel on Site Rick Belan, Robert Vandervort (Radian); Dr. Sim Lessley (UBLT); Dr. Howard Ross, Claron Mackelprang, Robert Blac, Bruce Sibbit (UURI)

Time (Military)	Activity or Event
0815	Called Radian (Austin) spoke with Robert Wallace in reference to hydrologic budget at Hill AFB. Landfills Nos. 3 and 4 areas.
0820	Called Earth Exploration and Drilling to coordinate with Ed Fleming or me of smaller solid stam auger.
0830	Called Radian (SLC) and coordinated with Robert Vandervort on upcoming project meeting with UBTL.
0855	Spoke with Dr. S. Lessley on meeting with UBTL on pojrect. Departed to Salt Lake City.
1045	Attending a meeting between UBTL, UURI and Radian. We discussed project results to date, especially pertaining to Chemical Disposal Pit No. 3. The 5 soil borings, piezometers and resistivity survey verified that Chemical Disposal Pit No. 3's geologic complexity. Based upon these field results Rick recommended that the proposed 6-inch monitor well not be drilled at this time because good downgradient well placement could not be realiably determined at this time. Also, rather than a monitor well 4-5 additional auger borings would be appropriate to define the geology at Chemical Disposal Pit no. 3. Received from UURI two documents for reviewing. Meeting adjourned about 1145.
1200	Met with C. Mackelprang (UURI) for update of resistivity survey results at Hill AFB.
1330	Met with Dr. Sim Lessley to discuss project and coordinate activities. Picked up sample bottles for Tuesday sampling of Monitor Wells BPM-1 and W-7.
1500	Returned to Salt Lake office to coordinate activities and discuss project with Robert Vandervort and Gordon Allcott.
1630	End of day's activities.

RADIAN CORPORATION

Log of Daily Activities

Date 18 January 1983 (Tuesday)

Log Recorded By Rick Belan

Project Hill AFB IRP Phase II

Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan, Gordon Allcott (Radian)

Time (Military)	Activity or Event
0730	Worked up lysimeter sampling log program for Hill AFB personnel.
0912	Measured BPM-1 to determine if water level recovered from development bailing.
1000	Begin to bail Monitor Well BPM-1 to get samples which filled all UBTL sample bottles received. Bottled filled were cyanide, ICP screen, phenols, EPA 625, Metals O&G. Six (6) bottles to be about 1 qrt. each.
1100	Went to Monitor Well W-7 to bail sample after getting water from golf course maintenance building. Water had lots of residual chlorine, went to get distilled and fresher water.
1130	Bailed Monitor Well W-7 very little water 4 bails (very partial) got about a pint. 1145: will wait 15 minutes to get some more. Still not enougth to catch. Will wait until later this afternoon to try again.
1230	Gordon and Rick begin driving in protective stakes around the lysimeter.
1300	Went to Bioengineers to get lysimeter sampling assistance.
1320	Called UBTL to speak with Dr. Sim Lessley.
1330	Begin lysimeter sampling at Berman Pond and Chemical Disposal Pit. 3.
1550	End of lysimeter supply inventional all samples to date. G. Allcott will take samples to UBTL.
1600	Called Dr. S. Lessley about project and yesterday's meeting recommendations. He has relayed recommendation to Air Force awaiting answer.
1615	Gordon and Rick inventory water samples for him to take to UBTL.

RADIAN CORPORATION

Log of Daily Activities

Date 18January 1983 (Tuesday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan, Gordon Allcott (Radian)

Time (Military)	Activity or Event
1700	Gordon departs to UBTL. Rick finishes up sample bottle inventory.
1720	Break.
1900	Working up day's activities and logging to water samples.
2100	End of day's activities.

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Sheet 1 of 2

Log of Daily Activities

Date 19 January 1983 (Wednesday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Blean, (Radian); Royal Taylor, Ed Hitt, Dick (Sam) Kagie (CDI)

Time (Military)	Activity or Event
0745	Called UOP Johnson to find out about their formation packers applicable to our piezometers. Spoke with Joe Ranier and he'll check on the requested details and relay to our Salt Lake office.
0805	Called Bill Case Secretary of Utah Geological Association for a report pertinent to this study.
0818	Called CDI to coordinate activities. Farrell will bring out 5 more monitor well locks and remaining stainless steel screens Thursday. The crew will be working today on the remaining wells surface features.
0840	Went to pick up field well completion supplies for Chemical Disposal Pit 3.
0930	Steam cleaned field steel tape for sounding wells.
1000	Called Earth Exploration & Drilling and spoke with Ed Fleming about next potential auger work.
1005	Called UBTL Dr. Sim Lessley not availalbe.
1006	Called Radian (SLC) and coordinated with Robert Vandervort.
1100	CDI at Monitor Well M-4 preparing to finish out rest of well surface items. Monitoring their activities.
1120	Picked up CP-3 surface casing to take for drilling air breather holes at base maintenance.
1150	Worked up field cost projections. Spoke with R. Vandervort and discussed project. Called UBTL and spoke with Dr. Sim Lessley. He had spoked with Dr. D.A. Sanders (Brooks AFB) and received the OK to conduct up to 5 additional borings at Chemical Disposal No. 3.
1300	Took CP3 piezometer tops to golf course maintenance shop for drilling and painting.

RADIAN CORPORATION

Sheet 2 of 2

Log of Daily Activities

Date 19 January 1983 (Wednesday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian); Royal Taylor, Ed Hitt, Dick (Sam) Kagie (CDI)

Time (Military)	Activity or Event
1330	Went to take static water levels (SWW) at Chemical Disposal Pit No. 3 of the piezometers.
1430	Completed CP-3 SWL measurements. Check on CDI activities.
1455	Conducting a monitor well completion inventory before releasing CDI.
1515	Placed piezometer caps back on at Chemical Disposal Pit No. 3.
1600	Completed well inventory and provided a copy to Sam (CDI).
1615	Coordinated with Bioengineer for lysimeter sampling assistance for Thursday about 1:00 p.m., also for a place to store the remaining stainless steel screens.
1630	Called Earth Exploration and Drilling that we've received the OK to proceed with additional augering.
1650	Went to a local cement supplier and Ideal Rock Company to find a suitable gravel material for gravel packing the next piezometers at Chemical Disposal Pit 3. Ideal Rock Company appears to have a suitable gravel, need to see it in the morning as they were about to close up for the day.
1730	Break.
2000	Working up field activities and planning next augering at Chemical Disposal Pit No. 3.
2230	End of day's activities.

RADIAN CORPORATION

Sheet 1 of 2

Log of Daily Activities

Date 20 January 1983 (Thursday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian); Ed Hitt, Royal Taylor, Dick (Sam) Kagie (CDI)

Time (Military)	Activity or Event
0735	Called Austin office to coordinate activities. Spoke with Jerry Parr about Neoprene packer. UOP Johnson could send us one to test. He did not see a problem with neoprene but noted it could be a very minor influrence but is probably reaonsable for using. Spoke with Ann St.Clair and she noted can we get a sample of packer. I noted we probably could.
0840	Completed discussions with Austin office. Called CDI to coordinate activities.
0910	Went to Ideal Rock Company, South Weber close to Hill AFB to check available gravel. They have a 1-inch minus and a 3/8-inch minus both areas exposed aggregate. These are acceptable.
0940	Picked up respirators, cartridges. Also picked up Hill AFB water hose from CDI dog house which had coordinated with Farrell Peterson. Returned water hose and accessories to Hill AFB Fire department.
1003	Called UBTL and spoke with Dr. Sim Lessley and the budget for the next set of hollow-stem auger (about $2,500-$3,000) also he'll get soil sample bottles up today.
1045	Called Earth Exploration and Drilling and left message about continuing drilling efforts.
1100	Went to bail sample monitor well W-7. Could only get about 1/4 bottle for phenols. Well empty.
1145	Completed sampling attempt at Monitor Well W-7. Went to Berman Pond and CDI on-site to pick up dog hose, received 12 new security locks for monitor wells and piezometers.
1200	Called Earth Exploration and Drilling and coordinated with Dave Moffitt for Friday's next activities of solid steam augering at Chemical Disposal Pit No. 3.

RADIAN CORPORATION

Sheet 2 of 2

Log of Daily Activities

Date 20 January 1983 (Thursday)

Log Recorded By Rick Belan

Project Hill AFB IRP Phase II

Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan (Radian); Ed Hitt, Royal Taylor, Dick (Sam) Kagie (CDI)

Time (Military)	Activity or Event
1330	Begin to collect lysimeter samples, lysimeter pump won't hold vacuum; need to repair it.
1500	Take lysimeter samples back to Bioengineer and arrange for sampling assistance Friday.
1700	Lysimeter vacuum pump repaired put suction in lysimeters BPL-1 and L-4. Gauge desn't seem to be holding correctly. Go to repair vacuum pump again.
1800	End of day's activities, vacuum pump seems to be working OK.

RADIAN CORPORATION

Sheet 1 of 2

Log of Daily Activities

Date 21 January 1983 (Friday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian)

Time (Military)	Activity or Event
0730	Working up administration activities for the day.
0800	Coordinate with Maj. Gaudet at Biogengineer's for monitor well screen storage. Dropped off lysimeter pump with Bioengineer and sampling instructions.
0815	Notified CDT Farrell Peterson of well screen storage space and to contact Maj. Gaudet/SSgt. Rollins at Bldg. 242 at Bioengineer for storage.
0830	At Chemical Disposal Pit No. 3 to begin augering activities.
0910	Called Earth Exploration and Drilling. They will be ready Tuesday, said fine.
0920	Went with Mr. Chestnut (golf course maintenance) to observe an old well down by landfill-4 he recalled. Found a ∿8" mill slot casing unlocked next to '76 series well. Clark DeMill (6-3996) at roads and grounds may have information on wells in the area of landfill 4/3. They have an old airphoto print of golf course area (∿1971?) 1" = 100 ft. showing golf course. Wayne Bolt may have one showing landfill operations. He called Wayne but picture did not go that far. Turf equipment address: 2006 W. 15 St., Salt Lake (972-4164) took the pictures. Ray Welchman (snow removal & Mr. Gardenend (?)) cut work in landfill area may know of wells.
1045	Placed new locks on two old wells 8" mill slotted casing (1 by 1976 monitor well and 1 north of firing range entrance, about 150 ft.)
1115	I could not locate geothermal well No. 1. Went to Chemical Disposal Pit No. 3 to measure piezometer P-5, measuring point above second level.

RADIAN CORPORATION

Log of Daily Activities

Date 21 January 1983 (Friday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian)

Time (Military)	Activity or Event
1200	Took soil sample bottles to Bioengineer, went to Civil Engineer. I spoke with Keith Davis about the 2 old mill slotted wells by landfill-4. He noted that the wells were there before they started their studies. He was not aware of any records or anybody that's knowledgeable.
1230	Went to Salt Lake office and coordinated with Robert Vandervort and Gordon Allcott. Worked on field program.
1700	End of day's activities.

RADIAN CORPORATION

Sheet 1 of 1

Log of Daily Activities

Date 24 January 1983 (Monday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian)

Time (Military)	Activity or Event
0830	Conducting data review (UGA #1, Landslides, Soils report) and field program planning and analysis.
1300	Spoke with R. Vandervort on project, and coordinated field activities with G. Allcott. Continue on project data and field studies.
1600	End of day's activities.

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CORPORATION

Log of Daily Activities

Date 25 January 1983 (Tuesday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan, Gordon Allcott (Radian); Dave Moffitt, Toni (Earth Exploration and Drilling)

Time (Military)	Activity or Event
0700	Working up Chemical Disposal Pit No. 3 bailing scenario.
0815	Went to pick up supplies from Bioengineers. Spoke with SSgt. Rolling on samples and reviewed noted. Still some problems with lysimeter pump need to check it out. He'll be available about 1230-1300 p.m. to help Gordon Allcott sample lysimeters.
0900	At Chemical Disposal No. 3, no one here yet (i.e., EE&D). Weather is cold and foggy.
0914	Called Earth Exploration and Drilling to check on field work. They had to wait for 2-inch PVC delivery. They are on their way out.
0930	Met Gordon and briefed him on day's activities and field work set up.
0945	Dave (EE&D) at Chemical Disposal Pit No. 3 but rig is not
1000	Rig on-site, but no gravel. Have to get gravel. Rick will take drillers to gravel supply, went at 1010.
1030	At Ideal Rock Supply. I selected 3/8" minus 'exposed aggregate' gravel. Short $3. Returned to base.
1100	Rick returned to Ideal Rock Supply to pay $3 to gravel firm. Dave and Mark set up on next auger hole. Begin second round of hollow-stem augering and sampling at Chemical Disposal Pit No. 3. Next hole is CP3A-7 to be piezometer P-6 if ground water is encountered.
1155	Recovered strong solvent smelling split-spoon sample (Trich?) from 20.5-21.5 feet, no free water. Insured that drillers use protective gloves and impervious boots to protect against contact. Also, slicker suits to be used if we get free water or operation where the drillers person would contact potentially contaminated drilling equipment. Briefed drillers on contamination safety and equipment use.

RADIAN CORPORATION

Sheet 2 of 2

Log of Daily Activities

Date 25 January 1983 (Tuesday) Log Recorded By Rick Belan
Project Hill AFB IRP Phase II Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan, Gordon Allcott (Radian); Dave Moffitt, Toni (Earth Exploration and Drilling)

Time (Military)	Activity or Event
1230	Will continue to auger and sample to complete a piezometer. Gordon finished development bailing on the completed piezometers. He bailed water to waste into 55 gallon drums provided by base Civil Engineers.
1320	Down to about 26 1/2 ft. in a sand and can smell solvent from cuttings returning to surface. We shovel into plastic bags and remove cuttings to protect working conditions.
1357	Possible clay at about 40 ft. in auger hole CP3A-7, will take split-spoon sample to confirm clay. Then complete a piezometer.
1430	Rick went to get Hill AFB Base Fire Department hose, wrenches, etc. for decontaminating drilling equipment. Called Dr. Sim Lessley (UBTL) and briefed him on activities.
1520	Dave and Toni got down to 40 ft. but very fine sand is heaving into auger flights. The auger bit gets stuck, working it out.
1628	Finally freed the auger flights. The bit was stuck inside the flights by very fine sand which heaved.
1640	End of augering activities. Washed off gloves and boots.
1700	End of day's activities.

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RADIAN CORPORATION

Sheet 1 of 1

Log of Daily Activities

Date 26 January 1983 (Wednesday) Log Recorded By Rick Belan

Project Hill AFB IRP Phase II Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan (Radian); Dave Moffitt, Mark Ybarra (Earth Exploration & Drilling); Gordon Allcott (Radian)

Time (Military)	Activity or Event
0750	Begin field activities and purchased distilled water for cleaning sampling equipment. Went to Chemical Disposal Pit No. 3 and measured piezometer static water levels.
0900	Earth Exploration and Drilling arrive on-site and prepare for drilling activities.
1000	Dave and Mark took the water truck to get base water so we can try to maintain a hydraulic head in order to complete a piezometer P-6 in auger hole CP3A-7.
1005	Spoke with Gordon and coordinated bailing activities based upon yesterday's bailing results.
1025	Dave and Mark return with water. Begin augering. Still having problem with sand binding and heaving.
1145	Called Ed Fleming (EE&D) for auger o-rings and equipment to aid in auger operations.
1410	Finally got piezometer P-6 down and completed to about 40 ft. Begins rig and equipment wash down.
1440	Moving to auger hole CP3A-8, which became piezometer P-7. We'll be using protective gloves and boots.
1500	Begin solid stem augering and split-spoon sampling. All clay after 5 feet.
1625	Down to 32 feet in clay and split-spoon sample had a solvent smell (Trich?).
1655	It appears that solvent is in ground water at a contact between a red and grey clay. We'll leave it open hole for the night to see where the ground water comes to. Wash down, Dave and Mark depart.
1735	End of day's activities after taking split-spoon samples to Bioengineer's for refrigerator storage.

RADIAN CORPORATION

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Log of Daily Activities

Date 27 January 1983 (Thursday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan (Radian); Dave Moffitt, Mark Ybarra (Earth Exploration and Drilling)

Time (Military)	Activity or Event
0800	Begin field activities, purchased distilled water for split-spoon decontamination. Went to Chemical Disposal Pit No. 3 and measured all static water levels for planning boiling development.
0910	Dave and Mark arrive begin drilling. I had them clean out hole CP3A-8. Took a Shelby tube sampler from about 30 feet. We extruded the clay sample and it had a solvent smell appears to be right at a red and grey clay contact. We begin to complete a piezometer (P-7).
1245	Piezometer P-7 completed, moved rig forward about 5 feet to take a soil sample from about 5 feet.
1300	Moved to auger hole CP3A-9 and began augering and taking split-spoon samples.
1400	Hit water at about 25 feet then a clay at about 29 1/2 feet. We'll complete a piezometer here then move forward about 10 feet to go deeper and see if we can hit a deeper zone similar to piezometer P-7. So far nothing unusual with cuttings no obvious contamination. I tell Dave and Mark to discard any regular work gloves used when we don't need the chemical gloves.
1525	Hole collapsed therefore we'll proceed to auger deeper to get deeper ground water (i.e., red and grey clay contact).
1600	Have grey clay on drill stems at about 45 feet. Take split-spoon sample and grey clay is obtained. We'll complete a piezometer (P-8).
1715	Completed piezometer, no contamination observed. Wash up. Dave and Mark depart for the day.
1730	Took soil samples to Bioengineers and briefed Ltc. Maynard Moody.
1800	End of day's activities.

RADIAN CORPORATION

Sheet 1 of 1

Log of Daily Activities

Date 28 January 1983 (Friday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan, Gordon Allcott (Radian); Dave Moffitt, Mark Ybarra (Earth Exploration & Drilling); Keith Davis, Bill Taylor (Hill AFB, Civil Engineers)

Time (Military)	Activity or Event
0800	Begin field activities. Purchased 1-inch PVC bailing materials. Went to Chemical Disposal Pit No. 3 for augering and measurement activities.
0910	Dave and Mark arrive. I asked them to use the large hollow-stem auger around P-8 to have a 6-inch hole around the piezometer instead of the approx. 4 1/2" solid stem hole for surface casing and cementing operations. Done; moved about 10 feet east to auger a hole for a shallower piezometer than P-8.
1000	Gordon arrives and we discuss field activities and bailing for sampling. Gordon departs to get more barrels for waste bailing water and resume bailing on monitor wells. Keith and Bill arrive with 10 more barrles and I briefed them.
1200	Down to about 30 feet with hollow-stem auger and prepare to complete a piezometer (P-9).
1320	Piezometer P-9 completed move to auger hole CP3P-10 and begin augering, and split-spoon sampling.
1510	Reached T.D. with split-spoon sample to about 30 feet, proceed to complete a piezometer at about 26 feet about where water was encountered. Design is to position screen above screen position at piezometer P-6.
1630	Completed piezometer P-10 (CP3A-10). Wash down; then Dave and Toni depart for day. Rick discussed activities with Gordon, he departs for the day.
1700	Took soil samples to Bioengineers. End of day's activities.

RADIAN CORPORATION

Sheet 1 of 1

Log of Daily Activities

Date 31 January 1983 (Monday)　　Log Recorded By Rick Belan

Project Hill AFB IRP Phase II　　Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Blean, Gordon Allcott (Radian); Dave Moffitt, Mark Ybarra (Earth Exploration & Drilling)

Time (Military)	Activity or Event
0730	Called Ann St. Clair (Radian, Austin), not in so I left a message. Worked up week's activities.
0840	Begin field activities at Chemical Disposal Pit No. 3. Measured static water levels.
0915	Dave and Mark arrive. First task is to solid-stem auger a hole next to piezometer P-5 for a new lysimeter. Gordon arrives and assists on the new lysimeter activities. Dave and Mark switch over and begin piezometer surface casing, capping and cementing.
1230	Gordon finishes out new lysimeter L-3 (CP3L-3), and begins bailing development activities.
1305	Went to Bioengineer to make calls and pick up items.
1330	Went to Civil Engineers to coordinate sampling of Base Well No. 4.
1356	Called CDI to coordinate with Farrell Peterson on remaining field tasks. He plans to come out Tuesday and finish up.
1500	Back at Chemical Disposal Pit No. 3. Dave and Mark informed me that piezometer P-7 broke off when they were augering the 4-inch hole to 6-inches for surface casing emplacement per my instructions. We work on trying to salvage piezometer. Work on carefully digging out to the piezometer.
1630	Piezometer uncovered at about 4 feet below ground level, slipped over a new piece of 2-inch PVC. Rick begins to bail and make ground-water level measurements.
1800	Completed bailing and ground water level measurements at piezometer P-7. Dave and Mark have departed for the day.
1830	End of day's activities after finalizing P-7 measurement checks.

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RADIAN CORPORATION

Sheet 1 of 2

Log of Daily Activities

Date 1 February 1983 (Tuesday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site R. Belan (Radian); Claron Mackelprang (ESC)

Time (Military)	Activity or Event
0800	Called Earth Exploration and Drilling to coordinate activities.
0835	Called Gordon Allcott to coordinate activities and sampling.
0840	Called UBTL to coordinate with Dr. Lessley, but at a meeting and Jim Cochran also not available.
0905	Dave and Mark arrive at Chemical Disposal Pit No. 3 to conduct piezometer completion activities.
1015	Completed static water level measurements. Begin to bail Piezometer P-7 to clean it out.
1105	End of bailing to clean piezometer. Water had strong solvent smell (trich?). I'm not sure piezometer is ok from damage.
1135	Made measurement at Piezometer P-7 and data checks.
1150	Trying again to use A-rod to clean out bottom of piezometer.
1208	Still no luck. 1st let's pull the 2-inch PVC and redrill. Pulled all but 5 feet of PVC screen in.
1225	Will now go back down to clean out hole with hollow stem auger to 32 ft.
~1300	Claron came by. He is running an S.P. survey today. He said good results at Berman Pond. He would not do it here today because of our present activities that would potentially disturb his readings.
1315	Hollow-stem augering down to 32 feet. Can see PVC chips and old bentonite seal we had emplaced. Getting ready to emplace new 2-inch PVC.
1425	Set 35.4' PVC have now added gravel of 1-inch minus exposed aggregate then about 1 gallon volclay.
1455	Sounded annulus at 9 ft. BGL adding bentonite, will now cement up from 7-0 feet.

RADIAN CORPORATION

Log of Daily Activities

Date 1 February 1983 (Tuesday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site R. Belan (Radian); Claron Mackelprang (UURI)

Time (Military)	Activity or Event
1510	Went to piezometer P-6 to try and use vacuum pump for developing.
1540	Set up vacuum pump at piezometer P-6 and start pumping. Pumped about 32 minutes, discharge smell of solvent, then suction broke due to water level drawdown. Discharge smell of solvent.
1705	Began to bail piezometer P-7 (23 times) discharge murky, brown, smells. Clean up equipment.
1830	End of day's activities.

RADIAN CORPORATION

Sheet 1 of 1

Log of Daily Activities

Date 2 February 1983 (Wednesday) Log Recorded By Rick Belan

Project Hill AFB IRP Phase II Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan, Robert Vandervort, Gordon Allcott (Radian)

Time (Military)	Activity or Event
0800	Went to return Base fire equipment for K. Davis. Returned 1 hose, 1 nozzle, 1 key, and 1 "Y" adaptor.
0830	Called G. Allcott to coordinate activities.
0850	Called EE&D to notify one of the piezometer (P-6) latch feel apart and needs repair. I spoke with Ed Flemming.
0900	Called Dr. Lessley and briefed him on peizometer. He said that G. Allcott noted broked sample bottles at Bioengineer which froze. I said CP-3 is now completed for the second set of augering activities.
1100	At Salt Lake City office to work on administrative items and monthly report for UBTL.
1305	Called Austin offices coordinated and updated field status.
1435	Met with R. Vandervort to discuss project. 1. Wednesday good for R.V., Tuesday not good for out brief. 2. R.V. noted that modification needs to go in in February to be sure the appropriate hours are adequately covered

RADIAN CORPORATION

Sheet 1 of 1

Log of Daily Activities

Date 3 February 1983 (Thursday) Log Recorded By Rick Belan

Project Hill AFB IRP Phase II Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site Rick Belan, Gordon Allcott (Radian)

Time (Military)	Activity or Event
0700	Working on monthly report.
0815	Called Salt Lake office to coordinate with Gordon on today's activities.
0830	Begin field activities. Very cold and windy this a.m.
0955	Called Base Water Supply to coordinate Base Well No. 4 sampling for Monday 7 February.
1000	Called Dr. S. Lessley to coordinate activities.
1045	At Chemical Disposal Pit No. 3 to begin bailing. Extremely cold weather and windy. Gordon assists bailing of piezometers. Rick continued bail development at piezometer P-6.
1330	Completed bailing at Chemical Disposal Pit #3; break for lunch.
1430	Continue field activities. Took care of administrative items went to Salt Lake Office to finish monthly report. Stopped by Rosemont Park, North Salt Lake to view slurry well operations of a hazardous waste site, all closed up. Resumed monthly report and field data workup at office.
2030	End of day's activities.

RADIAN CORPORATION

Sheet 1 of 1

Log of Daily Activities

Date 4 February 1983 (Friday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Hill AFB, Utah
Personnel on Site Rick Belan, Gordon Allcott (Radian)

Time (Military)	Activity or Event
0730	Begin working up a "base reference" static water level table for Chemical Disposal Pit No. 3.
0830	Pick up field supplies at store.
0930	At Hill AFB and begin activities at Chemical Disposal Pit No. 3. Gordon arrives and we measure relative piezometer heights with a hand level. This is in order to compute a common reference plane for determining the relative static water level positions.
1100	Resume bailing activities.
1300	Rick found out he had an emergency at home. Called R. Vandervort and coordinated for departing the field.
1430	End of Rick's field activities. Coordinated with Gordon for completing remaining Hill AFB activities. Rick will not be returning as estimated remaining field tasks to be short. Depart to pack and make flight arrangements for a Saturday departure. Gordon will stop by the apartment to pick up my field gear and equipment after he completed building activities.

RADIAN CORPORATION

Sheet 1 of 1

Log of Daily Activities

Date 5 February 1983 (Saturday)

Log Recorded By Rick Belan

Project Hill AFB IRP Phase II

Corresponding Tape # N/A

Location Hill AFB, Utah

Personnel on Site --

Time (Military)	Activity or Event
0630	Depart to Salt Lake City, turn in field car, catch Austin flight. End of R. Belan direct field activities.

RADIAN CORPORATION

Log of Daily Activities

Date 10 February 1983 (Thursday)
Log Recorded By Rick Belan
Project Hill AFB IRP Phase II
Corresponding Tape # N/A
Location Austin, Texas
Personnel on Site --

Time (Military)	Activity or Event
	Completed working up remaining field tasks for the Hill AFB IRP Field Investigation and sent to Gordon Allcott, Salt Lake City, Utah. The following tasks were completed by Gordon the last half of February and into March.
	Completed all first round of ground water and lysimeter sampling and resampling with UBTL.
	Return key(s) to Radian SLC office (2) and Bioengineer (1). Major Gaudet at Bioengineer gets his key back and documented its return. Also sent well keys for Gordon and Clive.
	Gave monitor well security keys to LTC Moody, Bioengineer; and/or find out the number he desires. I've sent "6" keys.
	Returned my Hill AFB vehicle pass and I.D. to base security.
	Returned book back to UURI Dr. H. Ross.
	Received cell constant that UBTL determined for Cond. Meters. UBTL noted field/lab OK but field temperatures are the main reason for variations between field and lab measurements.
	Measured at Chemical Disposal Pit No. 3 the locations of P-7, P-8, P-9 to locate on UURI resistivity survey map. Also measured the distance of my soil boring line from UURI line #2. Flagged area around P-6 and P-7 to warn of soil contamination.
	Inventoried, identified all old monitor wells.

RADIAN CORPORATION

Log of Daily Activities

Date February 1983

Log Recorded By Rick Belan

Project Hill AFB IRP Phase II

Corresponding Tape # N/A

Location

Personnel on Site --

Time (Military)	Activity or Event
	Identified, marked, and flagged old monitor wells that have been broken up for a new elevation survey. Purchased PVC protective caps as needed for the old monitor wells.
	Coordinated with K. Davis (Hill AFB, C.E.) for surveying assistance for all new monitor wells, piezometers, and selected monitor wells before surveys went out.
	Sounded all old monitor wells (nearest 1/10 ft.).
	Measured marked "old monitor wells" measuring points above ground level (nearest 1/10 ft.).
	Measured static water levels all old wells and new wells (nearest 1/100 ft.).
	Took temperature measurements of static water levels and sounded bottom as possible for GC-1, Landfill 3 and 4 and Chem Pit 1 & 2 area wells and Chemical Disposal Pit 3 piezometers.
	Took conductivity measurements at same time of temperature measurements.
	Contacted Base Weather (Lt. Vankovics) for getting a copy of Climatic Brief to obtain average rainfall values for the month.
	Measured steel tape and sketched the length and width of the golf course parking lot to be able to estimate rainfall recharge to our waste sites.
	Checked if any infrared photos may be available for the waste sites but particularly Chemical Disposal Pit No. 3. Checked with K. Davis and base weather.
	Coordinated and obtained a copy of a soil survey report which covered the study areas.
	Decontaminated field equipment.

APPENDIX E: SAMPLING AND ANALYTICAL PROCEDURES

- Monitor Well and Piezometer Sampling
- Lysimeter Sampling
- Soil Sampling
- Table E-1: Summary of Water Analysis Procedures
- Table E-2: Summary of Soil Analysis Procedures
- Discussion of Soil Analysis Procedures
- Chain of Custody Forms

(pp. E-1 through E-35)

APPENDIX E: SAMPLING AND ANALYTICAL PROCEDURES

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- Lysimeter Sampling
- Soil Sampling
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(pp. E-1 through E-35)

E-1 2

Monitor Well and Piezometer Sampling

All new monitor wells and piezometers were developed by bailing along with selected existing monitor wells. Periodically during development, field measurements were made of groundwater for water levels, temperature, conductivity and pH. An electrical water level sounding line (Soil Test Model DR-772) was used to measure groundwater levels. To obtain relative water quality, a combination conductivity and temperature meter (Yellow Springs Instruments Model YSI 33 SCI) was used while pH was measured with a Cole Parmer Model 5987-20 meter. These various measurements permitted monitoring of the progress of each monitor well and piezometer's development.

All of the wells and piezometers constructed under this program were found to be very low producers. Three or more well volumes were discharged prior to sampling to ensure that fresh formation water was sampled. Due to the formation's low productivity, only about half well volumes were withdrawn at any one bailing to minimize sediments from development. Development of the wells and piezometers occurred over a period of days to reach the three volume target.

Procedures were implemented during the field sampling activities in order to reduce the chances of sample contamination, or cross-contamination. All monitor wells and piezometers were ordered and prioritized for development and sampling. Wells were sampled as practical: upgradient before downgradient, deep before shallow, and least contaminated zones before most contaminated zones near the disposal sites.

Three different bailing ropes were used, each solely dedicated to specific type sampling points or a disposal site to reduce the possibility of cross-contamination. One rope was used for only the Berman Pond monitor wells, one for the shallow, and one for the deep monitor wells at Chemical Disposal Pits Nos. 1 and 2 and Landfill No. 3 areas.

One bailer at Chemical Disposal Pit No. 3 was dedicated to Piezometer P-6 during development. This was due to the great amount of solvents detected during the completion of the piezometer, while the other

piezometers appeared to have low levels of solvents. Bailing activities at the other 2-inch piezometers were conducted with another separate bailer.

Groundwater samples were collected with a PVC ball valve bailer. Two bailers, a 3 1/2-inch and a 1 1/6-inch, were used for the 6-inch monitor wells and 2-inch piezometers, respectively. The sample was then poured directly into an appropriate clean glass or plastic sampling container provided by UBTL. In some cases, either due to small sample retrieval and/or small analyte container, the bailed sample was first placed into a clean beaker. This permitted the collection of enough bailed sample, reduced spillage, and careful placement of sample into small containers. UBTL provided all sample containers with preservation material in the container.

Once the groundwater sample had been obtained, it was poured directly into a labeled container. The label was marked in indelible ink with the sample date, location, time, and sample identifier. Each sample container was then tightly sealed, taped as appropriate, and placed in an ice chest with frozen "blue ice" for temporary field storage. Most field samples were then taken directly to the laboratory for analyses. Other samples which had to composited were temporarily stored in the Base Bioenvironmental Engineer's refrigerator for pick up.

Throughout the monitor and piezometer development for sampling, protective clothing was worn which consisted of slicker suits, rubber boots, protective gloves and splash goggles. The discharge water was emptied into 55-gallon drums provided by the Air Force to protect the ground and personnel from suspected contaminated water. The drums remained at each well or piezometer until chemical analyses were completed so that recommendations for final disposition could be determined. The bailers were thoroughly rinsed between wells and piezometers using distilled and/or Base potable water. In addition, a rinse of methanol followed by distilled water was performed for the piezometers at Chemical Disposal Pit No. 3 where solvents were detected.

In most cases, the sample collection was conducted jointly between Radian and UBTL after which UBTL took samples directly back to the lab. In some instances, especially during compositing of samples, the samples were not taken directly by UBTL back to the laboratory. The samples were temporarily stored at the Bioenviromnental Engineer's refrigerator for collection and planned pick up by UBTL. A chain of custody form was principally used at this time for transferring custody of the samples from the Bioenvironmental Engineers to UBTL. The chain of custody forms are provided at the end of this appendix.

Lysimeter Sampling

After the installation of each lysimeter and closing off one of its two lines, about 65 centibars of vacuum were placed on it for obtaining a soil water sample. A sanitary tape was placed over each lysimeter line to insure keeping the ends of the line clean and unobstructed. The vacuum was allowed to draw on the lysimeter for up to a day to collect soil water. To collect any water captured in the lysimeter, the system was pressurized with a hand pump to discharge the water out of the other line and directly into a sample container.

Samples from the lysimeters were generally easier to collect than samples from the monitor wells and piezometers. This was because, in all cases, the small volumes of soil moisture collected could be emplaced directly into the sample containers without any intermediate containers, thus reducing double-handling and the chances of outside contamination.

It was found also that, due to the small water volumes produced, it was necessary to pull samples over a period of days. This was mostly due to the small amount of soil moisture available. In some cases, this required compositing samples in order to obtain the required volumes for chemical analysis. Several different samples containers and a priority order for filling the containers was established in the event that insufficient soil water could not be collected. Personnel from the Base Bioenvironmental Engineers assisted in this task, after sampling and safety instruction by Radian and receiving UBTL sampling priority instructions.

During the sampling of the lysimeters, minimal personnel safety equipment was needed. The equipment used were safety or splash glasses and protective gloves. Once the samples were collected, the same preservation procedures, storage, and handling techniques were used as for groundwater samples.

Soil Sampling

Soil samples for chemical analyses were obtained with a hand auger. This activity was conducted jointly by Radian and UBTL. The basic procedure was to auger to a selected depth and extract a soil sample. The sample was then placed into a one liter amber glass jar provided by UBTL and tightly secured. The jar was labeled and marked like those for monitor wells described earlier. The auger was cleaned off and washed as required. Handling, storage, and transfer procedures were the same as for the previously discussed monitor wells. Minimal protective gear was required, such as safety glasses and/or rubber gloves.

Table E-1
Summary of Water Analysis Procedures
- Physical Properties, Metals and Inorganic Nonmetallics -

Analysis	Units	Detection Limit	Analytical Method	Comments
TOC	mg/L	2	EPA 415.1	Total Organic Carbon
TOX	μg/L	10	EPA 450.1	Total Organic Halogens
O&G	mg/L	5	EPA 413.1	Oil and Grease
Phenol	μg/L	10	EPA 420.1-2	
MBAS	mg/L	0.2	EPA 425.1	Methylene Blue Active Substances (Surfactants)
TDS	mg/L	1	EPA 160.1	Total Dissolved Solids Oven temperature was 180°C
Cyanide	μg/L	10	EPA 335.2-3	
Sulfate	mg/L	10	EPA 375.2	
Arsenic	μg/L	10	EPA 206.2	
Barium	μg/L	100	EPA 208.1	
Beryllium	μg/L	10	EPA 210.1	
Cadmium	μg/L	10	EPA 213.2	
Chromium	μg/L	50	EPA 218.2	
Copper	μg/L	20	EPA 220.2	
Iron	μg/L	100	EPA 236.1	
Lead	μg/L	10	EPA 239.2	
Manganese	μg/L	20	EPA 243.2	
Mercury	μg/L	0.2	EPA 245.1	
Zinc	μg/L	10	EPA 289.1	
Conductance	μmho/cm	1	EPA 120.1	
Calcium	mg/L	1	EPA 215.1	
Magnesium	mg/L	1	EPA 242.1	
Sodium	mg/L	1	EPA 273.1	
Potassium	mg/L	1	EPA 258.1	
Carbonate	mg/L	1	EPA 310.2	In combination with Technicon Method 201-72W, reported as $CaCO_3$
Bicarbonate	mg/L	1	EPA 310.2	In combination with Technicon Method 201-72W, reported as $CaCO_3$
Chloride	mg/L	1	EPA 325.2	
Fluoride	mg/L	0.1	EPA 340.3	
Nitrate	mg/L	0.02	EPA 353.2	
Hardness	mg/L	1	EPA 130.1	Reported as $CaCO_3$
Silica	mg/L	1	EPA 370.1	

Table E-1 (continued)
Summary of Water Analysis Procedures
- Purgeable Organics -

Purgeable Halocarbons	Units	Detection Limit	Analytical Method	Comments
Methylene Chloride	µg/L	1	EPA 601	The reported detection limit was raised for some samples because dilutions were necessary.
1,1,1-Trichloroethane	µg/L	1	EPA 601	
Carbon Tetrachloride	µg/L	1	EPA 601	
Trichloroethene	µg/L	1	EPA 601	
1,1,2-Trichloroethane	µg/L	1	EPA 601	
1,1,2,2-Tetrachloroethane	µg/L	1	EPA 601	
Chloromethane	µg/L	1	EPA 601	
Bromomethane	µg/L	1	EPA 601	
Dichlorodifluoromethane	µg/L	1	EPA 601	
Vinyl Chloride	µg/L	1	EPA 601	
Chloroethane	µg/L	1	EPA 601	
Trichlorofluoromethane	µg/L	1	EPA 601	
1,1-Dichloroethene	µg/L	1	EPA 601	
1,1-Dichloroethane	µg/L	1	EPA 601	
trans-1,2-Dichloroethene	µg/L	1	EPA 601	
Chloroform	µg/L	1	EPA 601	
1,2-Dichloroethane	µg/L	1	EPA 601	
Bromodichloromethane	µg/L	1	EPA 601	
1,2-Dichloropropane	µg/L	1	EPA 601	
trans-1,3-Dichloropropene	µg/L	1	EPA 601	
Dibromochloromethane	µg/L	1	EPA 601	
cis-1,3-Dichloropropene	µg/L	1	EPA 601	
2-Chloroethylvinyl ether	µg/L	1	EPA 601	
Bromoform	µg/L	1	EPA 601	
Tetrachloroethene	µg/L	5	EPA 601	
Chlorobenzene	µg/L	1	EPA 601	
1,3-Dichlorobenzene	µg/L	5	EPA 601	
1,2-Dichlorobenzene	µg/L	5	EPA 601	
1,4-Dichlorobenzene	µg/L	5	EPA 601	

Table E-1 (continued)
Summary of Water Analysis Procedures
- Purgeable Organics -

Purgeable Aromatics	Units	Detection Limit	Analytical Method	Comments
Benzene	μg/L	1	EPA 602	
Toluene	μg/L	1	EPA 602	
Ethyl benzene	μg/L	1	EPA 602	
m-Xylene	μg/L	1	EPA 602	
p-Xylene	μg/L	1	EPA 602	
o-Xylene	μg/L	1	EPA 602	
Chlorobenzene	μg/L	1	EPA 602	
1,2-Dichlorobenzene	μg/L	1	EPA 602	

Table E-1 (continued)
Summary of Water Analysis Procedures
- Metals Screen -

ICP Screen	Units	Detection Limit	Analytical Method	Comments
Sodium	mg/L	1.3	Contractor	
Potassium	mg/L	2.5	Contractor	
Calcium	mg/L	0.3	Contractor	
Magnesium	mg/L	0.5	Contractor	
Iron	mg/L	0.03	Contractor	
Aluminum	mg/L	0.6	Contractor	
Silicon	mg/L	0.3	Contractor	
Titanium	mg/L	0.2	Contractor	
Phosphorus	mg/L	0.6	Contractor	
Strontium	mg/L	0.02	Contractor	
Barium	mg/L	0.6	Contractor	
Vanadium	mg/L	1.3	Contractor	
Chromium	mg/L	0.05	Contractor	
Manganese	mg/L	0.3	Contractor	
Cobalt	mg/L	0.03	Contractor	
Nickel	mg/L	0.2	Contractor	
Copper	mg/L	0.06	Contractor	
Molybdenum	mg/L	1.3	Contractor	
Lead	mg/L	0.3	Contractor	
Cadmium	mg/L	0.06	Contractor	
Silver	mg/L	0.05	Contractor	
Gold	mg/L	0.1	Contractor	
Arsenic	mg/L	0.6	Contractor	
Antimony	mg/L	0.8	Contractor	
Bismuth	mg/L	2.5	Contractor	
Uranium	mg/L	6.3	Contractor	
Tellurium	mg/L	1.3	Contractor	
Tin	mg/L	0.2	Contractor	
Tungsten	mg/L	0.2	Contractor	
Lithium	mg/L	0.05	Contractor	
Beryllium	mg/L	0.005	Contractor	
Zirconium	mg/L	0.2	Contractor	
Lanthanum	mg/L	0.2	Contractor	
Cerium	mg/L	0.3	Contractor	
Thorium	mg/L	2.5	Contractor	
Boron	mg/L	0.2	Contractor	

Table E-1 (continued)
Summary of Water Analysis Procedures
- Gas Chromatography/Mass Spectrometry Screen -

Purgeable Compound	Units	Detection Limit	Analytical Method	Comments
Chloromethane	µg/L	320	EPA 624	
Bromomethane	µg/L	90	EPA 624	
Vinyl chloride	µg/L	420	EPA 624	
Chloroethane	µg/L	90	EPA 624	
Dichloromethane	µg/L	8	EPA 624	
Trichlorofluoromethane	µg/L	8	EPA 624	
1,1-Dichloroethene	µg/L	8	EPA 624	
1,1-Dichloroethane	µg/L	8	EPA 624	
trans-1,2-Dichloroethene	µg/L	8	EPA 624	
Chloroform	µg/L	8	EPA 624	
1,2-Dichloroethane	µg/L	8	EPA 624	
1,1,1-Trichloroethane	µg/L	8	EPA 624	
Carbon tetrachloride	µg/L	8	EPA 624	
Bromodichloromethane	µg/L	8	EPA 624	
1,2-Dichloropropane	µg/L	8	EPA 624	
trans-1,3-Dichloropropene	µg/L	8	EPA 624	
Trichloroethene	µg/L	8	EPA 624	
Dibromochloromethane	µg/L	8	EPA 624	
1,1,2-Trichloroethane	µg/L	8	EPA 624	
cis-1,3-Dichloropropene	µg/L	8	EPA 624	
Benzene	µg/L	8	EPA 624	
2-Chloroethylvinyl ether	µg/L	8	EPA 624	
Bromoform	µg/L	8	EPA 624	
1,1,2,2-Tetrachloroethane	µg/L	8	EPA 624	
Tetrachloroethene	µg/L	8	EPA 624	
Toluene	µg/L	8	EPA 624	
Chlorobenzene	µg/L	8	EPA 624	
Ethylbenzene	µg/L	8	EPA 624	
Acrolein	µg/L	8	EPA 624	
Acrylonitrile	µg/L	8	EPA 624	

Table E-1 (continued)
Summary of Water Analysis Procedures
- Gas Chromatography/Mass Spectrometry Screen -

Base/Neutral Extractable Compound	Units	Detection Limit	Analytical Method	Comments
1,3-Dichlorobenzene	µg/L	1	EPA 625	
1,4-Dichlorobenzene	µg/L	1	EPA 625	
Hexachloroethane	µg/L	3	EPA 625	
Bis(2-chloroethyl)ether	µg/L	5	EPA 625	
1,2-Dichlorobenzene	µg/L	1	EPA 625	
Bis(2-chloroisopropyl) ether	µg/L	3	EPA 625	
N-nitroso-di-n-propyl amine	µg/L	15	EPA 625	
Nitrobenzene	µg/L	8	EPA 625	
Hexachlorobutadiene	µg/L	1	EPA 625	
1,2,4-Trichlorobenzene	µg/L	1	EPA 625	
Isophorone	µg/L	3	EPA 625	
Naphthalene	µg/L	3	EPA 625	
Bis(chloroethoxy)methane	µg/L	6	EPA 625	
Hexachlorocyclo-pentadiene	µg/L	*		
2-Chloronaphthalene	µg/L	2	EPA 625	
Acenaphthylene	µg/L	3	EPA 625	
Acenaphthene	µg/L	3	EPA 625	
Dimethyl phthalate	µg/L	1	EPA 625	
2,6-Dinitrotoluene	µg/L	5	EPA 625	
Fluorene	µg/L	2	EPA 625	
4-Chlorophenyl phenyl ether	µg/L	3	EPA 625	
2,4-Dinitrotoluene	µg/L	12	EPA 625	
Diethyl phthalate	µg/L	1	EPA 625	
N-nitrosodiphenyl amine	µg/L	**		
Hexachlorobenzene	µg/L	3	EPA 625	
4-Bromophenyl phenyl ether	µg/L	2	EPA 625	
Phenanthrene	µg/L	3	EPA 625	
Anthracene	µg/L	3	EPA 625	
Di-n-butyl phthalate	µg/L	1	EPA 625	
Fluoranthene	µg/L	3	EPA 625	
Pyrene	µg/L	3	EPA 625	
Benzidine	µg/L	*		
Butyl benzyl phthalate	µg/L	7	EPA 625	
Bis(2-ethylhexyl)-phthalate	µg/L	1	EPA 625	
Chrysene	µg/L	10	EPA 625	
Benzo(a)anthracene	µg/L	5	EPA 625	
3,3'-Dichlorobenzidine	µg/L	10	EPA 625	
Di-n-octyl phthalate	µg/L	3	EPA 625	
Benzo(b)fluoranthene	µg/L	1	EPA 625	
Benzo(k)fluoranthene	µg/L	5	EPA 625	
Benzo(a)pyrene	µg/L	3	EPA 625	
Indeno(1,2,3-c,d)pyrene	µg/L	3	EPA 625	
Dibenzo(a,h)anthracene	µg/L	5	EPA 625	
Benzo(g,h,i)perylene	µg/L	8	EPA 625	
N-nitrosodimethylamine	µg/L	**		

Table E-1 (continued)
Summary of Water Analysis Procedures
- Gas Chromatography/Mass Spectrometry Screen -

Pesticides Screened in Base/Neutral Extracts	Units	Detection Limit	Analytical Method	Comments
alpha-BHC	µg/L	*		
gamma-BHC	µg/L	*		
beta-BHC	µg/L	3	EPA 625	
Heptachlor	µg/L	3	EPA 625	
delta-BHC	µg/L	3	EPA 625	
Aldrin	µg/L	3	EPA 625	
Heptachlor epoxide	µg/L	3	EPA 625	
Endosulfan I	µg/L	*		
Dieldrin	µg/L	4	EPA 625	
4,4'-DDE	µg/L	3	EPA 625	
Endrin	µg/L	*		
Endosulfan II	µg/L	*		
4,4'-DDD	µg/L	3	EPA 625	
4,4'-DDT	µg/L	5	EPA 625	
Endosulfan sulfate	µg/L	5	EPA 625	
Chlordane	µg/L	*		
Toxaphene	µg/L	*		

Acid Extractable Compound	Units	Detection Limit	Analytical Method	Comments
2-Chlorophenol	µg/L	2	EPA 625	
2-Nitrophenol	µg/L	2	EPA 625	
Phenol	µg/L	1	EPA 625	
2,4-Dimethylphenol	µg/L	1	EPA 625	
2,4-Dichlorophenol	µg/L	2	EPA 625	
2,4,6-Trichlorophenol	µg/L	2	EPA 625	
4-Chloro-3-methylphenol	µg/L	2	EPA 625	
2,4-Dinitrophenol	µg/L	30	EPA 625	
2-Methyl-4,6-dinitrophenol	µg/L	20	EPA 625	
Pentachlorophenol	µg/L	3	EPA 625	
4-Nitrophenol	µg/L	10	EPA 625	

* Compound is decomposed by the extraction process.
**Compound decomposes in the injection port of the GC.

Table E-2

Summary of Soil Analysis Procedures

Analysis	Units	Detection Limit	Analytical Method	Comments
TOC	mg/g	2	EPA 415.1*	Total Organic Carbon
TOX	μg/g	5	EPA 8.56*	Total Organic Halogens
O&G	μg/g	5	EPA 413.1*	Oil and Grease
Phenol	μg/g	10	EPA 420.1-2*	
Cyanide	μg/g	10	EPA 335.2-3*	
Beryllium	μg/g	4	EPA 210.1*	
Cadmium	μg/g	4	EPA 213.1*	
Chromium	μg/g	20	EPA 218.1*	
Moisture	%	--	Contractor*	

* See Discussion of Soil Analysis Procedures (below)

Discussion of Soil Analysis Procedures

The following paragraphs describe the laboratory soil handling procedure, the modifications made to analytical methods for soil and the moisture determination procedure.

Soil Sample Handling

Introduction

The objective of the soil sampling and analysis program was to help define the boundaries of three landfill areas: Chemical Disposal Pits Nos. 1 and 2, Berman Pond and Chemical Disposal Pit No. 3. The materials for which the analyses were performed were presumed to be present in significant quantities (in the pit) or not present at all (outside of the pit). The soils were analyzed as received and the results corrected for moisture content in order to avoid loss of analytes during a drying step. In view of these considerations, the following approach to the handling and analysis of the soil samples was developed.

Storage

Before analysis, all samples were stored under refrigeration and protected from light.

Safety

At a minimum, gloves, a lab coat and safety glasses were worn while handling the bulk samples. The working surface was covered with a plastic-backed absorbent material. All samples were handled in a hood.

Initial Handling

Containers and implements of glass, aluminum or stainless steel were used for sample handling.

If the sample was lumpy in appearance or contained rocks, wood, glass, etc., it was poured out onto a 9.5 mm stainless steel sieve. The lumps of soil were broken up to pass through the sieve. The weight of the

material retained on the screen was recorded along with the total sample weight (top loading balance, ± 1 gram). The composition of the retained material was noted and it was discarded.

The sample was mixed well and quartered. (This was done on aluminum foil.) Quartering was accomplished by pouring the mixed sample out into a conical heap and dividing the heap into quarters by means of two perpendicular cuts which crossed in the center of the heap. One pair of opposite quarters were set aside or returned to the sample container. The remaining pair of opposite quarters were combined, mixed and again quartered until a sample of the desired size was obtained. A sample consisted of two opposite quarters combined. One quarter by itself was not considered a representative sample.

TOC

A five to ten milligram portion of soil was weighed into a TOC vial and 5 mL of distilled, deionized water were added to the vial. This mixture was then handled as a normal sample according to the referenced method.

The results were calculated as follows:

$$\mu\text{g TOC per gram of sample} = \frac{\text{mg TOC/L} \times 5\text{ mL} \times 1000\text{ mg/g} \times 1000\ \mu\text{g/mg}}{\text{mg of sample} \times 1000\text{ mL/L}}$$

TOX

A five gram portion of soil was weighed out into a 50 mL screw cap tube and tumbled with distilled, deionized water for 30 minutes. The mixture was filtered through a glass fiber filter. The filtrate was then analyzed according to the procedure for a water sample.

The results were calculated as follows:

$$\mu\text{g TOX per gram of sample} = \frac{\text{mg TOX/L} \times 25\text{ mL} \times 1000\ \mu\text{g/mg}}{\text{mg of sample} \times 1000\text{ mL/L}}$$

Recovery studies were performed using a sample of uncontaminated surface soil from Hill AFB. In separate trials, two compounds were spiked onto samples of the soil and analyzed. The results are summarized below:

Compound	Amount Spiked	Recovery
2,4,6-Trichlorophenol	10 μ/g	53%
Trichloroethylene	10 μ/g	36%

Based upon this limited recovery it can be surmised that the reported TOX values are probably low. The reported TOX values were not corrected for recovery.

Oil and Grease

A five gram portion of soil was weighed into a 50 mL screw cap tube and extracted with three 25 mL portions of Freon 113 (1,1,2-trichlorotrifluoroethane). Each extraction cycle was carried out by shaking the tube and contents for 10 minutes. After the soil settled, the Freon 113 was removed with a Pasteur pipet. The combined extracts were evaporated to dryness at 40-45°C in a tared container. The residue was weighed and reported as mg oil and grease per gram of sample.

Phenol

A two gram portion of soil was weighed into a one-liter distillation flask and 500 mL of distilled, deionized water were added to the flask. The contents of the flask were distilled and analyzed as water sample.

The results were calculated as follows:

$$\mu g \text{ phenol per gram of sample} = \frac{\mu g \text{ phenol/L} \times 500 \text{ mL}}{\text{g of sample} \times 1000 \text{ mL/L}}$$

Cyanide

A two-gram portion of soil was weighed into a one-liter distillation flask and 500 mL of distilled, deionized water were added to the flask. The contents of the flask were distilled and analyzed as a water sample.

The results were calculated as follows:

$$\mu g \text{ cyanide per gram of sample} = \frac{\mu g \text{ cyanide/L} \times 500 \text{ mL}}{\text{g of sample} \times 1000 \text{ mL/L}}$$

Beryllium, Cadmium and Chromium

A one gram portion of soil was digested with nitric and perchloric acids and brought to a final volume of 25 mL. Each solution was then analyzed for the three metals by flame atomic absorption spectrophotometry according to the referenced water analysis methods.

The results were calculated as follows:

$$\mu g \text{ metal per gram of sample} = \frac{\mu g \text{ metal/mL} \times 25 \text{ mL}}{\text{g of sample}}$$

Moisture

A five gram portion of soil was weighed into a tared aluminum pan and dried at 105 °C for approximately 16 hours. The pan with its contents was reweighed. The weight loss was calculated and reported as % moisture.

CHAIN OF CUSTODY FORMS

RADIAN CORPORATION

CHAIN OF CUSTODY RECORD

FIELD SAMPLE NO. 2

COMPANY SAMPLED/ADDRESS Hill AFB

SAMPLE POINT DESCRIPTION Hand Auger Points on Base

STREAM CHARACTERISTICS:

TEMPERATURE N/A FLOW N/A pH N/A

VISUAL OBSERVATIONS/COMMENTS Soil + Waste samples from Berman Pond Chemical Pits No 2+3

COLLECTOR'S NAME Rick Belan + Jim Cochran DATE/TIME SAMPLED 10-21-82 throughout day

AMOUNT OF SAMPLE COLLECTED 11 - 1 liter bottles of soil sample

SAMPLE DESCRIPTION Samples BP-11, 15, 17, 110, 311, 78 - CP-2, 3, 4 - CPB-1+2

STORE AT: ☐ AMBIENT ☐ 5°C ☐ -10°C ☒ OTHER Blue Ice

☐ CAUTION - NO MORE SAMPLE AVAILABLE ☐ RETURN ALL PORTIONS ☐ RETURN UNUSED PORTION OF SAMPLE

OTHER INSTRUCTIONS - SPECIAL HANDLING - HAZARDS Hazard waste

☒ HAZARDOUS SAMPLE (SEE BELOW) ☐ NON-HAZARDOUS SAMPLE

☐ TOXIC	☐ SKIN IRRITANT	☐ FLAMMABLE (FP 40°C)
☐ PYROPHORIC	☐ LACHRYMATOR	☐ SHOCK SENSITIVE
☐ ACIDIC	☐ BIOLOGICAL	☐ CARCINOGENIC - SUSPECT
☐ CAUSTIC	☐ PEROXIDE	☐ RADIOACTIVE

☐ OTHER Taking samples to detect exact nature of waste.

SAMPLE ALLOCATION / CHAIN OF POSSESSION:

ORGANIZATION NAME UBTL

RECEIVED BY James J. Cochran DATE RECEIVED 10-21-82 5PM.

LAB SAMPLE NO. See Description Above. COMMENTS

INCLUSIVE DATES OF POSSESSION

ORGANIZATION NAME

RECEIVED BY DATE RECEIVED

LAB SAMPLE NO. COMMENTS

INCLUSIVE DATES OF POSSESSION

ORGANIZATION NAME

RECEIVED BY DATE RECEIVED

LAB SAMPLE NO. COMMENTS

INCLUSIVE DATES OF POSSESSION

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CHAIN OF CUSTODY REPORT

Contract Name Hill AFB Type of Samples Soil samples
Contract No. — Number of Samples 18

COLLECTION MEDIUM

Type: Soil/Waste Sample Lot No: N/A
Prepared by: Jim Cochran & Rick Baker Date 11-2-82
Prep. Procedure: Put on Blue Ice
Recorded (Lab Notebook No) N/A

SAMPLE ORIGIN

Sample No.'s	Collection Medium I.D.	Date of Collection	Comments
CP-1,5,6,7	—	11-2-82	Samples taken using a shovel.
8,9,10,11			Sample Collected by Jim Cochran
12,13,14			& Rick Baker
15,16,16a			
17,18,19,			
20			

Site of Origin Hill AFB Chemical Disp Pit 1+2
Sampling Location Sent to UBTL
Recorded (Notebook No) 66730

This is to verify that the samples designated and described above were collected by me on the date indicated, and that any anomolies were noted and recorded in a laboratory notebook, on a field data sheet, or on this sheet.

Signed James J Cochran / RB Baker Date 11/2/82

SAMPLE TRANSFER RECORD

Samples Recieved from	Samples Received by (signed)	Date of Transfer	Comments
Rick Baker	James J. Cochran	11-2-82	Transferred to UBTL in field

ANALYSIS RECORD

Type of Analysis	Performed by (signed)	Date of Analysis	Recorded (Lab Book No)	Comments
	N/A			

CHAIN OF CUSTODY REPORT

Contract Name: Hill AFB — Type of Samples: Soil Sampling

Contract No.: — — Number of Samples: 15

COLLECTION MEDIUM

Type: Soil & Waste Sample — Lot No: N/A

Prepared by: Jim Cochran & Rick Bolan — Date: 11-4-82

Prep. Procedure: Put on Blue Ice

Recorded (Lab Notebook No): [redacted] - pg 2 of 00730

SAMPLE ORIGIN

Sample No.	Collection Medium I.D.	Date of Collection	Comments
CP3-3,6,	—	11-4-82	Samples taken with a hand
14,5A,5B			auger as drilled; QC
7,13A,13B			Sampling Collected by R Bolan
11,10,4,9			and Jim Cochran.
12,8,			
QC			

Site of Origin: Hill AFB Chem. Disp. Pits #3

Sampling Location: Same

Recorded (Notebook No): 00730

This is to verify that the samples designated and described above were collected by me on the date indicated, and that any anomolies were noted and recorded in a laboratory notebook, on a field data sheet, or on this sheet.

Signed: Rick E. Bolan — Date: 11-4-82

SAMPLE TRANSFER RECORD

Samples Recieved from	Samples Received by (signed)	Date of Transfer	Comments
R.A. Bolan	James J. Cochran	11-4-82	Turned over to Waste in field.

ANALYSIS RECORD

Type of Analysis	Performed by (signed)	Date of Analysis	Recorded (Lab Book No)	Comments
As in Proposal	N/A			

CHAIN OF CUSTODY REPORT

Contract Name Hill AFB
Type of Samples Soil Samples
Contract No. —
Number of Samples -10-

COLLECTION MEDIUM

Type: Soil ~~and~~ Samples
Lot No: N/A
Prepared by: Rick Bolan
Date 11-10 to 11-17-82
Prep. Procedure: Put into Bioengineer freezer
Recorded (Lab Notebook No) page 2 of Notebook 00730 RADIAN

SAMPLE ORIGIN

Sample No.	Collection Medium I.D.	Date of Collection	Comments
M-1(14-18),(27-32)		11-10-82	Composite air rotary drill cutting samples
M-2(10-10),(25-30)		11-11-82	" " " " " "
M-4(18-22),(24-26)		11-12-82	" " " " " "
M-9(0-7),(7-10)		11-12-82	" " " " " "
M-2(13-16),(17-22)		11-17-82	" " " " " "

Site of Origin Samples taken from the vicinity of Chem Pit ~~and~~ and Landfill 3
Sampling Location at Hill Air Force Base Utah
Recorded (Notebook No) 00730 RADIAN

This is to verify that the samples designated and described above were collected by me on the date indicated, and that any anomolies were noted and recorded in a laboratory notebook, on a field data sheet, or on this sheet.

Signed Rick G. Bolan
Date 11-17-82

SAMPLE TRANSFER RECORD

Samples Recieved from	Samples Received by (signed)	Date of Transfer	Comments
[illegible] ABC	[illegible]	11-19-82	Hold for pick up by USTL [illegible]
[illegible]	[illegible]	11-14-82	USTL picked up Soil Samples

ANALYSIS RECORD

Type of Analysis	Performed by (signed)	Date of Analysis	Recorded (Lab Book No)	Comments

CHAIN OF CUSTODY REPORT

Contract Name Hill AFB Type of Samples Soil Samples
Contract No. – Number of Samples -2-

COLLECTION MEDIUM

Type: Soil Samples Lot No: N/A
Prepared by: Date 11-26-82
Prep. Procedure: Put in Bioengineer freezer
Recorded (Lab Notebook No)

SAMPLE ORIGIN

Sample No.	Collection Medium I.D.	Date of Collection	Comments
M-10(2-5)		11-26-82	Composite air rotary drill cutting samples
M-10(~13)		11-26-82	" " " " "

Site of Origin Samples taken at Monitor Well M-10 North of Landfill-3
Sampling Location Hill AFB, Utah.
Recorded (Notebook No) 00730 RADIAN

This is to verify that the samples designated and described above were collected by me on the date indicated, and that any anomolies were noted and recorded in a laboratory notebook, on a field data sheet, or on this sheet.

Signed [signature] Date 11-26-82

SAMPLE TRANSFER RECORD

Samples Recieved from	Samples Received by (signed)	Date of Transfer	Comments
E. Artez	William E. Taylor	11-26-82	To take sample to Bio Engineer
Bill Taylor	Glenn L Gaudet	11-26-82	Hold for USTL Pickup from Engine
G L Gaudet	Sheila Crowe	12-14-82	" " " " " " "
Sheila Crowe	James J. Carden	12/14/82	" " " " " " "

ANALYSIS RECORD

Type of Analysis	Performed by (signed)	Date of Analysis	Recorded (Lab Book No)	Comments
	N		A	

CHAIN OF CUSTODY REPORT

Contract Name Hill AFB
Type of Samples Soil Samples
Contract No. —
Number of Samples -17-

COLLECTION MEDIUM

Type: Soil Samples
Lot No: N/A
Prepared by: R.A. Belan and Chris Mechum
Date 12-2/3/6/10-82
Prep. Procedure: Put in Biohazard Freezer
Recorded (Lab Notebook No) —

SAMPLE ORIGIN

Sample No.	Collection Medium I.D.	Date of Collection	Comments
M-3(5-10) (24-30)		12-2/3-82	Composite for Rotary cuttings
BP-11(A B);		12-6-82	Hand Auger samples
BP-5(A B), BP-5(C), BP-8(A B)		//////////	//////////////////
BP-7(A B), CS-5(A B)		12-10-82	Hollow stem Auger-Split Spoon Sample
CS-6(A B), CS-4(A B)		//////////	//////////////////

Site of Origin Hill AFB waste disposal areas Berman Pond, Chemical Pit 1,2+3; M-Well #10
Sampling Location Hill AFB Utah
Recorded (Notebook No) Ø573Ø RADIAN

This is to verify that the samples designated and described above were collected by me on the date indicated, and that any anomolies were noted and recorded in a laborqtory notebook, on a field data sheet, or on this sheet.

Signed [signature] Date 12-10-82

SAMPLE TRANSFER RECORD

Samples Recieved from	Samples Received by (signed)	Date of Transfer	Comments
[signature]	Sheila Crowe	12-14-82	Held for USATC pick up
Sheila Crowe	James J. [signature]	12/14/82	" " " " "

ANALYSIS RECORD

Type of Analysis	Performed by (signed)	Date of Analysis	Recorded (Lab Book No)	Comments

CHAIN OF CUSTODY REPORT

Contract Name Hill AFB Type of Samples Soil Sample
Contract No. – Number of Samples -4-

COLLECTION MEDIUM

Type: Soil Sample Lot No: N/A
Prepared by: R. Bailey Date 12-10-82
Prep. Procedure: [illegible]
Recorded (Lab Notebook No) [illegible]

SAMPLE ORIGIN

Sample No.	Collection Medium I.D.	Date of Collection	Comments
Brm-1 (A)		12-10-82	[illegible]
Brm-1 (B)		"	"
Brm-1 (C)		"	"
Brm-1 (D)		"	"

Site of Origin Hill AFB
Sampling Location [illegible] Brm-1
Recorded (Notebook No) [illegible]

This is to verify that the samples designated and described above were collected by me on the date indicated, and that any anomolies were noted and recorded in a laboratory notebook, on a field data sheet, or on this sheet.

Signed [signature] Date 12-10-82

SAMPLE TRANSFER RECORD

Samples Recieved from	Samples Received by (signed)	Date of Transfer	Comments
R A Bailey	[signature]	12-10-82	N/A

ANALYSIS RECORD

Type of Analysis	Performed by (signed)	Date of Analysis	Recorded (Lab Book No)	Comments

CHAIN OF CUSTODY REPORT

Contract Name Hill AFB Type of Samples Soil Samples
Contract No. — Number of Samples - 7 -

COLLECTION MEDIUM

Type: Soil Samples Lot No: ——
Prepared by: R R Belan Date As Noted
Prep. Procedure: Placed in Glass Jars for containment
Recorded (Lab Notebook No) 2023 RAPIOR

SAMPLE ORIGIN

Sample No.	Collection Medium I.D.	Date of Collection	Comments
Depth			
CP3A-6 (17½ - 19½)	—	1-12-83	Split Spoon Sample
CP3A-5 (25-27 ft)	—	1-10-83	" " "
CP3A-4 (19-20)	—	1-6-83	" " "
CP3A-3 (20.5-22)	—	1-6-83	" " "
BPM-2 (A) (10-12)	—	12-18-82	Air Rotary composite Sample
BPM-2 (B) (20-22)	—	12-18-82	" " " "
BPM-2 (C) (23-25)	—	12-18-82	" " " "

Site of Origin Hill AFB
Sampling Location Waste Disposal Field
Recorded (Notebook No) 0023 RAPIOR

This is to verify that the samples designated and described above were collected by me on the date indicated, and that any anomolies were noted and recorded in a laboratory notebook, on a field data sheet, or on this sheet.

Signed [signature] Date 1-14-83

SAMPLE TRANSFER RECORD

Samples Recieved from	Samples Received by (signed)	Date of Transfer	Comments
RR Belan	James J. Cook	1-14-83	Turned over to [illegible]

ANALYSIS RECORD

Type of Analysis	Performed by (signed)	Date of Analysis	Recorded (Lab Book No)	Comments

SAMPLE INVENTORY
WELL + LYSIMETERS 1-18-83

1/18/83 GHA - RB   To

Sample	Date	No / identifier	
CP3-2	1/14/83	601	
LBP-1	1/14/83	TOC/TOX	
LBP-2	1/14/83	TOC/TOX	
CP3-2	1/14/83	TOC/TOX	
LBP-4	1/14/83	TOC/TOX	
LBP-2	1/14/83	Metals	
CP3-2	1/14/83	Metals	
LBP-1	1/14/83	Metals	
LBP-1	1/18/83	601	
LBP-1	1/18/83	602	
LBP-2	1/18/83	602	
LBP-2	1/18/83	601	
LBP-2	1/18/83	Phenols	
LBP-4	1/18/83	601	(1/2 plus.)
CP3-2	1/18/83	Cyanide	
CP3-2	1/18/83	~~601~~ 602	
CP3-1	1/18/83	601	(BAD contaminate - Need replacement Container - re sample)
CP3-1	1/18/83	Metals	ditto
CP3-1	1/18/83	TOC/TOX	(Need new container - no sample today)
BPM-1	1-18-83	Cyanide	
BPM-1	1-18-83	ICP Screen	
BPM-1	1-18-83	phenols	
BPM-1	1-18-83	EPA 625	
BPM-1	1-18-83	Metals	
		Oil + Grease	

RECEIVED BY [signature] 1/18/83 5:53 PM

Hill Air Force Base - Samples to UETL - 1/25/83

GAA

1) LBP 2 Cyanide. complete date 1/25/83 1420
(2) LBP 2 O & G. prior to 1/25/83

~~LBP~~

(3) W-7. Phenol 1/20/83 1135

(1) Auger hole # 7 (C) at chem pt 3. strong odor. 1/25/83
20.4 - 23.5
(2) Augar hole # 7 (B) at chem pt 3 1/25/83
19 - 20.4
(3) Auger Hole # 7 (A) at chem pt 3 1/25/83
5 - 5.7 (?)

S.G. Elliott Radian Corp. Received UETL X
1/25/83 Date. 25 JAN 83

5/11/83

For W-13
601 - 2 each
602 - 2 each
TOC
Metals
Phenol
MBAS, TDS, Sulfate
Cyanide
Oil & Grease
Hg
Extra

BPL2 - O&G
BPL4 - Metals
BPL1 - Metals
CPL3 - 601
CP3L1 - 601
BPL1 - 601
CP3L1 - TOC

Above samples received from Clive Mecham by Sim Leasley

Sim D. Leasley 5/11/83
Clive C. Mecham

BPL2 - Ca, Mg, Na
BPL2 - CN
CP3L1 - 601
BPL2 - "Replace Broken"
CP3L3 - 601

Received from Clive Mecham by Sim Leasley

Sim D. Leasley 5/10/83
Clive C. Mecham

APPENDIX F: ANALYTICAL DATA

(pp. F-1 through F-42)

The data presented in this appendix are grouped into four categories for ease of reference. The results of the soil sample analyses are presented first, followed by the results of the first episode of water sample analyses. The results of the ICP and GC/MS screening analyses are presented next; and the results of the second episode of water sample analyses are presented last.

Note 1.: In some cases analytical results are reported as "<X" when X is above the method detection limit listed. In such cases the presence of a chemical interference required raising the detection limit. This situation was particularly noticeable in the analysis of samples from Chemical Disposal Pit No. 3 for volatile compounds.

Note 2.: Additional compounds identified in the GC/MS screens for which no standards were run are reported as ranges based upon the response of a neighboring surrogate standard. The reported concentrations of the additional compounds should be regarded as semi-quantitative estimates.

APPENDIX F: ANALYTICAL DATA

(pp. F-1 through F-42)

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Note 2.: Additional compounds identified in the GC/MS screens for which no standards were run are reported as ranges based upon the response of a neighboring surrogate standard. The reported concentrations of the additional compounds should be regarded as semi-quantitative estimates.

Table F-1

Summary of Soil Sample Analyses for Chemical Disposal Pits No. 1 & 2 (Fall 1982)

Analysis	Units	CP1	CP2	CP3	CP4	CP5	CP6	CP7	CP8	CP9	CP10	CP11	CP12	CP13	CP14	CP15	CP16	CP16A	CP17	CP18	CP19	CP20
TOC	µg/g	4000	8400	4200	9900	8000	9100	17000	8900	15000	10000	10000	3600	3000	16000	24000	3300	6600	23000	2900	9300	17000
TOX	µg/g	<5	<5	<5	<5	<5	<6	<6	<5	<5	<5	<5	<5	<5	<6	<6	<5	<5	11	<5	<6	<6
O & G	mg/g	<5	22	<5	10	12	18	130	85	120	50	16	<5	<5	120	260	<5	<5	370	<5	<6	76
Phenol	µg/g	<11	<10	<10	<11	<11	<11	<11	<11	<11	<10	<11	<11	<11	67	34	<11	<11	380	<10	<11	<12
Moisture	%	4.9	1.7	1.5	6.4	8.8	10	12	7.5	6.0	3.9	5.3	5.3	5.4	11	13	6.6	7.6	19	4.5	12	16

Note: Results have been corrected for % moisture.

Table F-2

Summary of Soil Sample Analyses for Berman Pond (Fall 1982)

Analysis	Units	BP28A	BP28B	BP58A	BP58B	BP58C	BP75A	BP75B	BP77A	BP77B	BP111A	BP111B	BP11	BP15	BP17	BP38	BP110	BP311
TOC	µg/g	940	1000	1300	4200	650	680	990	630	900	1500	690	6000	2200	1100	630	2100	1300
TOX	µg/g	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<6	<5
O & G	mg/g	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	12	<5	<5	<5	<6	<5
Phenol	µg/g	<11	<11	43	<10	<10	<11	<10	<11	<10	<11	<10	<11	<11	<10	<10	<11	<10
Cyanide	µg/g	<11	<11	<11	<10	<10	<11	<10	<11	<10	<11	<10	<11	<11	<10	<10	<11	<10
Beryllium	µg/g	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Cadmium	µg/g	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	17	<4	<4	<4	<4	<4
Chromium	µg/g	<21	<21	<22	<20	<20	<21	<21	<21	<21	<21	<21	230	<22	<20	<21	<22	<21
Moisture	%	5.5	6.3	7.3	2.4	2.1	5.9	2.9	5.4	4.5	6.7	4.0	7.4	8.6	2.1	3.5	9.1	4.5

Note: Results have been corrected for % moisture.

Table F-3

Summary of Soil Sample Analyses for Chemical Disposal Pit No. 3 (Fall 1982)

Analysis	Units	CP3-1	CP3-2	CP3-3	CP3-4	CP3-5A	CP3-5B	CP3-6	CP3-6A	CP3-6B	CP3-7	CP3-8	CP3-9	CP3-10	CP3-11	CP3-12	CP3-13A	CP3-13B	CP3-14	CP3-15A	CP3-15B
TOC	ug/g	18000	14000	3100	13000	6800	4700	4900	2300	2700	6700	6000	12000	3800	7100	6600	1700	5400	8000	3500	3400
TOX	ug/g	<6	<6	<5	<6	<6	<6	<6	<5	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6
Cyanide	ug/g	<11	<12	<11	<12	<11	<11	<11	<11	<12	<12	<11	<12	<11	<11	<11	<10	<11	<11	<12	<12
Beryllium	ug/g	<4	5	<4	49	<5	<5	<5	<4	<5	<5	<4	<5	<4	<4	<5	<4	<5	<5	<5	<5
Cadmium	ug/g	7	290	<4	510	<5	<5	<5	<4	5	<5	<4	220	<4	<4	<5	<4	<5	<5	5	5
Chromium	ug/g	31	170	<22	260	<23	<23	<23	<22	<23	<23	<22	270	<22	<22	<23	<21	<23	<23	<24	<24
Moisture	%	11	14	7.9	15	12	13	13	7.2	14	14	10	18	10	9.3	13	3.7	13	13	15	17

Analysis	Units	CP3A-3	CP3A-4	CP3A-5	CP3A-6	CP3A-7A	CP3A-7B	CP3A-7C	CP3A-8A	CP3A-8B	CP3A-8C	CP3A-9	CP3A-10	CP3A-10A	CP3A-10B	CP3A-10C	CP3A-10D
TOC	ug/g	2900	2800	3100	3200	4100	1400	2300	4700	5400	3100	1300	2300	3500	620	2500	470
TOX	ug/g	<6	<6	<6	<6	<6	<5	<6	<6	<6	<5	<5	<6	<6	<5	<6	<6
Cyanide	ug/g	<12	<13	<12	<12	<12	<10	<12	<12	<13	<11	<10	<12	<11	<10	<12	<12
Beryllium	ug/g	<5	<5	<5	<5	<5	<4	<5	<5	<5	<4	<4	<5	<4	<4	<5	<5
Cadmium	ug/g	<5	<5	<5	<5	<5	<4	<5	<5	<5	<4	<4	<5	<4	<4	<5	<5
Chromium	ug/g	<24	<25	<24	<24	<23	<21	<24	<24	<26	<22	<21	<24	<22	<20	<24	<24
Moisture	%	18	21	16	18	14	4	17	15	22	7	4	16	11	2	15	15

Note: Results have been corrected for % moisture.

Table F-4

Summary of Water Sample Analyses for Chemical Disposal Pits No. 1 & 2, and Landfill No. 3, and the Golf Course Area (Winter 1982-83)

Analysis	Unit	M-1	M-2	M-3	M-4	M-6	M-7	M-7	M-9	M-9	M-10	GC-1	W-7	W-8
TOC	mg/L	14	51	4	8	1	3		14		1	3	5	2
TOX**	ug/L	110	950	90	170	40	70		280		50	70	30	110
O & G	mg/L	76	<5	<5	<5	<5	<5		<5		<5	6	*	<5
Phenol	ug/L	410	1200	20	20	10	<10		30		<10	70	*	10
MBAS	mg/L					<0.1	0.2		0.4		<0.1	0.2	<0.1	0.2
TDS	mg/L		840	340		360	490	550	2500	2900	680	1000	*	500
Cyanide	ug/L					<10	<10		<10		<10	<10	*	<10
Sulfate	mg/L		8	45		32	60	52	160	480	76	110	58	50
Arsenic	ug/L					<10	<10		<10		<10	<10	*	<10
Beryllium	ug/L					<10	<10		<10		<10	<10	*	<10
Cadmium	ug/L					<10	13		20		<10	<10	*	13
Chromium	ug/L					<50	<50		<50		<50	<50	*	<50
Copper	ug/L					<20	<20		<20		<20	<20	*	<20
Iron	ug/L		18000	<100		<100	<100	72	<100	2100	<100	<100	*	<100
Lead	ug/L					<20	<20		<20		<20	<20	*	<20
Manganese	ug/L		1100	170		230	140	240	1300	1500	230	440	*	46
Mercury	ug/L					<10	<10		<10		<10	<10	*	<10
Conduct.	umho/cm	1000	1300	640	1300	640		1000		4500	1200	1800	*	790
Calcium	mg/L		180	52		50		110		300	83	32		
Magnesium	mg/L		31	28		29		34		130	47	46		
Sodium	mg/L		49	43		40		89		470	74	210		
Potassium	mg/L		5	7		8		2		10	12	26		
Carbonate	mg/L		25	18		14		10		<1	22	30		
Bicarbonate	mg/L		520	200		240		300		530	340	410		
Chloride	mg/L		79	50		49		70		1000	150	230		
Fluoride	mg/L		0.2	0.3		0.4		0.4		0.2	0.3	1.0		
Nitrate	mg/L		0.61	0.36		0.25		3.3		0.04	0.03	5.4		
Hardness	mg/L		580	250		240		410		1300	400	270		
Silica	mg/L		29	11		14		14		17	18	6		
-601-**														
Dichloromethane	ug/L	<2	<2	<1	<2	<1	<2		<2		<1	<1	<1	<2
1,1,1-Tri-chloroethane	ug/L	<2	20	<2	8.8	<2	<2		<2		<2	<2	<2	20
Carbon tetrachloride	ug/L	<1	<1	78	18	<1	<1		<1		<1	<1	<1	<1
Trichloroethene	ug/L	1.3	<5	<1	49	<1	<1		125		8	<1	<1	5.2
1,1,2-Tri-chloroethane	ug/L	<1	<5	<1	<1	<1	<1		<1		<1	<1	<1	<1
1,1,2,2-Tetra-chloroethane	ug/L	<5	<5	<5	<5	<5	<5		<5		<5	<5	<5	<5
-602-														
Benzene	ug/L	220	25000	580	120	<1	<1		<1		<36	<1	<1	<1
Toluene	ug/L	13	920	2	<1	<1	<1		<1		<1	<1	<1	<1
Ethyl Benzene	ug/L	68	64	<1	<1	<1	<1		<1		5	3	<1	<1
Xylenes	ug/L	250	310	<1	<1	<1	<1		<1		<1	<1	<1	<1
Chlorobenzene	ug/L	1700	170	1	<1	<1	<1		<1		11	<1	<1	<1
1,2-Dichloro-benzene	ug/L	370	1900	<1	5	<1	<1		<1		200	<1	<1	<1

*Denotes sample not obtained.

**The discrepancies between TOX data and EPA Method 601 data are attributed to problems inherent in the TOX analysis.

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Table F-5

Summary of Water Sample Analyses for Berman Pond (Winter 1982-83)

Analysis	Unit	BPM-1	BPM-2	BPL-1	BPL-2	BPL-3	BPL-4
TOC	mg/L	2	3	5	4	*	18
TOX	μg/L	60	90	140	2800	*	640
O & G	mg/L	<5	<5	*	<5	*	*
Phenol	μg/L	30	20	10	<10	*	*
Cyanide	μg/L	<10	<10	*	<10	*	*
Beryllium	μg/L	<10	<10	<10	<10	*	<10
Cadmium	μg/L	<10	<10	<10	<10	*	<10
Chromium	μg/L	<50	<50	<50	<50	*	<50
Conduct.	μmho/cm	400	840				
-601-							
Dichloromethane	μg/L	<1	<1	<1	<1	*	<1
1,1,1-Tri chloroethane	μg/L	<2	13	<2	3	*	4
Carbon tetra- chloride	μg/L	<1	<1	1	<1	*	<1
Trichloroethene	μg/L	<1	5	<1	2	*	3
1,1,2-Tri- chloroethane	μg/L	<1	<1	<1	<1	*	<1
1,1,2,2-tetra- chloroethane	μg/L	<5	<5	<5	<5	*	<5
-602-							
Benzene	μg/L	<1	<1	<1	<1	*	*
Toluene	μg/L	<1	<1	1	<1	*	*
Ethyl benzene	μg/L	<1	3	1	2	*	*
Xylenes	μg/L	<1	21	<1	2	*	*
Chlorobenzene	μg/L	4	11	2	3	*	*
1,2-Dichloro- benzene	μg/L	4	<1	<1	<1	*	*

*Denotes sample not obtained.

Table F-6

Summary of Water Sample Analyses for Chemical Disposal Pit No. 3 (Winter 1982-83)

Analysis	Unit	P-1	P-2	P-3	P-4	P-5	P-6	P-7	P-8	P-9	P-10	CP3L-2*
TOC	mg/L	58	25	52	4	160	190	24	25	38	34	6
TOX**	μg/L	150	40	540	600	50	180,000	3,000	40	60	100	3,300
Cyanide	μg/L	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Beryllium	μg/L	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Cadmium	μg/L	<10	<10	<10	<10	<10	56	<10	<10	<10	<10	<10
Chromium	μg/L	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Conduct.	μmho/cm	800	920	1,100	1,100	910	1,200	1,800	750	700	80	
-601-**												
Dichloro-methane	μg/L	1	<1	7	<1	<1	39,000	100	3	1	16,000	<1
1,1,1-tri-chloroethane	μg/L	2,300	40	97	120	<1	150,000	170	64	89	81,000	170
Carbon tetra-chloride	μg/L	<100	<1	<10	<10	<1	<1,000	<10	<10	<10	<2,500	<1
Trichloroethene	μg/L	19,000	160	11,000	8,800	21	280,000	420,000	790	790	450,000	430
1,1,2-tetra-chloroethane	μg/L	<100	<10	<100	<100	<10	<1,000	<1,000	<100	<100	<2,500	<1
1,1,2,2-Tri-chloroethane	μg/L	<100	<3	<10	<10	<3	<1,000	<1,000	<100	<100	<2,500	220

Note: No samples were obtained from CP3L-1 or CP3L-3.

*The low results for volatiles in the sample from CP3L-2 is attributed to the use of vacuum in the collection of lysimeter samples.
**The discrepancies between the TOX data and the EPA Method 601 data are attributed to problems inherent in the TOX analysis.

Table F-7
Summary of ICP Analysis of Water Samples from
Chemical Disposal Pits No. 1 & 2,
Landfill No. 3 and the Golf Course Area (Winter 1982-83)
(milligrams per liter)

Analysis	Detection Limit	M-2	M-6	M-9	GC-1
Sodium	1.3	50	57	520	310
Potassium	2.5	6.6	9.8	13	38
Calcium	0.3	200	57	300	41
Magnesium	0.5	36	39	140	74
Iron	0.03	30	ND	0.03	ND
Aluminum	0.6	ND	ND	ND	ND
Silicon	0.3	21	9.3	9.4	4.0
Titanium	0.2	ND	ND	ND	ND
Phosphorus	0.6	ND	ND	ND	ND
Strontium	0.02	0.5	0.27	1.1	0.2
Barium	0.6	1.5	0.7	ND	ND
Vanadium	1.3	ND	ND	ND	ND
Chromium	0.05	ND	ND	ND	ND
Manganese	0.3	1.2	0.3	1.4	0.7
Cobalt	0.03	ND	ND	ND	ND
Nickel	0.2	ND	ND	ND	ND
Copper	0.06	ND	ND	ND	ND
Molybdenum	1.3	ND	ND	ND	ND
Lead	0.3	ND	ND	ND	ND
Zinc	0.2	0.3	0.7	0.6	0.6
Cadmium	0.06	ND	ND	ND	ND
Silver	0.05	ND	ND	ND	ND
Gold	0.1	ND	ND	ND	ND
Arsenic	0.6	ND	ND	ND	ND
Antimony	0.8	ND	ND	ND	ND
Bismuth	2.5	ND	ND	ND	ND
Uranium	6.3	ND	ND	ND	ND
Tellurium	1.3	ND	ND	ND	ND
Tin	0.2	ND	ND	ND	ND
Tungsten	0.2	ND	ND	ND	ND
Lithium	0.05	ND	ND	0.1	0.1
Beryllium	0.005	ND	ND	ND	ND
Zirconium	0.2	ND	ND	ND	ND
Lanthanum	0.2	ND	ND	ND	ND
Cerium	0.3	ND	ND	ND	ND
Thorium	2.5	ND	ND	ND	ND
Boron	0.2	0.3	0.2	1.6	0.5

Table F-8
Summary of ICP Analysis of Water Samples from Berman Pond
(milligrams per liter)

Analysis	Detection Limit	BPM-1	BPM-2
Sodium	1.3	34	87
Potassium	2.5	4.4	3.6
Calcium	0.3	19	74
Magnesium	0.5	8.6	13
Iron	0.03	ND	ND
Aluminum	0.6	ND	ND
Silicon	0.3	0.4	5.2
Titanium	0.2	ND	ND
Phosphorus	0.6	ND	ND
Strontium	0.02	0.08	0.19
Barium	0.6	ND	0.6
Vanadium	1.3	ND	ND
Chromium	0.05	ND	ND
Manganese	0.3	ND	0.7
Cobalt	0.03	ND	ND
Nickel	0.2	ND	ND
Copper	0.06	ND	ND
Molybdenum	1.3	ND	ND
Lead	0.3	ND	ND
Zinc	0.2	ND	0.7
Cadmium	0.06	ND	ND
Silver	0.05	ND	ND
Gold	0.1	ND	ND
Arsenic	0.6	ND	ND
Antimony	0.8	ND	ND
Bismuth	2.5	ND	ND
Uranium	6.3	ND	ND
Tellurium	1.3	ND	ND
Tin	0.2	ND	ND
Tungsten	0.2	ND	ND
Lithium	0.05	ND	ND
Beryllium	0.005	ND	ND
Zirconium	0.2	ND	ND
Lanthanum	0.2	ND	ND
Cerium	0.3	ND	ND
Thorium	2.5	ND	ND
Boron	0.2	ND	ND

Table F-9

Summary of GC/MS Analysis of Water Samples from Chemical Disposal Pits No. 1 & 2, Landfill No. 3 and the Golf Course Area (Winter 1982-83) (micrograms per liter)

Purgeable Compound	Detection Limit	M-2	M-6	M-9	GC-1
Chloromethane	320	ND	ND	ND	ND
Bromomethane	90	ND	ND	ND	ND
Vinyl chloride	420	ND	ND	ND	ND
Chloroethane	90	ND	ND	ND	ND
Dichloromethane	8	ND	ND	ND	ND
Trichlorofluoromethane	8	ND	ND	ND	ND
1,1-Dichloroethene	8	35	ND	ND	ND
1,1-Dichloroethane	8	1900	ND	15	ND
trans-1,2-Dichloroethene	8	7400	ND	730	ND
Chloroform	8	240	ND	ND	ND
1,2-Dichloroethane	8	58	ND	ND	ND
1,1,1-Trichloroethane	8	23	ND	<12	ND
Carbon tetrachloride	8	ND	ND	ND	ND
Bromodichloromethane	8	ND	ND	ND	ND
1,2-Dichloropropane	8	26	ND	<25	ND
trans-1,3-Dichloropropene	8	ND	ND	ND	ND
Trichloroethene	8	(5)*	ND	170	ND
Dibromochloromethane	8	ND	ND	ND	ND
1,1,2-Trichloroethane	8	ND	ND	ND	ND
cis-1,3-Dichloropropene	8	ND	ND	ND	ND
Benzene	8	133	ND	ND	ND
2-Chloroethylvinyl ether	8	ND	ND	ND	ND
Bromoform	8	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	8	ND	ND	ND	ND
Tetrachloroethene	8	(6)*	ND	ND	ND
Toluene	8	520	ND	ND	ND
Chlorobenzene	8	30	ND	14	ND
Ethylbenzene	8	44	ND	ND	ND
Acrolein	8	ND	ND	ND	ND
Acrylonitrile	8	ND	ND	ND	ND
Additional Purgeable Compounds					
Dichlorobenzenes	8	300-1400	ND	400-1600	ND

*Though below the calculated detection limit, these compounds were identified and are reported as qualitative results.

Table F-9 (continued)

Base/Neutral Extractable Compound	Detection Limit	M-2	M-6	M-9	GC-1
1,3-Dichlorobenzene	1	22	ND	48	ND
1,4-Dichlorobenzene	1	180	ND	170	ND
Hexachloroethane	3	ND	ND	ND	ND
Bis(2-chloroethyl)ether	5	ND	ND	ND	ND
1,2-Dichlorobenzene	1	880	ND	890	ND
Bis(2-chloroisopropyl)ether	3	ND	ND	ND	ND
N-nitroso-di-n-propyl amine	15	ND	ND	ND	ND
Nitrobenzene	8	ND	ND	ND	ND
Hexachlorobutadiene	1	ND	ND	ND	ND
1,2,4-Trichlorobenzene	1	41	ND	7	ND
Isophorone	3	ND	ND	ND	ND
Naphthalene	3	6	ND	ND	ND
Bis(chloroethoxy)methane	6	ND	ND	ND	ND
Hexachlorocyclopentadiene	*				
2-Chloronaphthalene	2	ND	ND	ND	ND
Acenaphthylene	3	ND	ND	ND	ND
Acenaphthene	3	ND	ND	ND	ND
Dimethyl phthalate	1	ND	ND	ND	ND
2,6-Dinitrotoluene	5	ND	ND	ND	ND
Fluorene	2	ND	ND	ND	ND
4-Chlorophenyl phenyl ether	3	ND	ND	ND	ND
2,4-Dinitrotoluene	12	ND	ND	ND	ND
Diethyl phthalate	1	ND	0.5-2	ND	3
N-nitrosodiphenyl amine	**				
Hexachlorobenzene	3	ND	ND	ND	ND
4-Bromophenyl phenyl ether	2	ND	ND	ND	ND
Phenanthrene	3	ND	ND	ND	ND
Anthracene	3	ND	ND	ND	ND
Di-n-butyl phthalate	1	ND	1	ND	3
Fluoranthene	3	ND	ND	ND	ND
Pyrene	3	ND	ND	ND	ND
Benzidine	*				
Butyl benzyl phthalate	7	ND	0.5-2	ND	ND
Bis(2-ethylhexyl)phthalate	1	ND	4	ND	3
Chrysene	10	ND	ND	ND	ND
Benzo(a)anthracene	5	ND	ND	ND	ND
3,3'-Dichlorobenzidine	10	ND	ND	ND	ND
Di-n-octyl phthalate	3	ND	3	ND	ND
Benzo(b)fluoranthene	1	ND	ND	ND	ND
Benzo(k)fluoranthene	5	ND	ND	ND	ND
Benzo(a)pyrene	3	ND	ND	ND	ND
Indeno(1,2,3-c,d)pyrene	3	ND	ND	ND	ND
Dibenzo(a,h)anthracene	5	ND	ND	ND	ND
Benzo(g,h,i)perylene	8	ND	ND	ND	ND
N-nitrosodimethylamine	**				

Table F-9 (continued)

Additional Base/Neutral Compounds	M-2	M-6	M-9	GC-1
2,2,4-Trimethyl-1,3-pentane diol-di-isobutyrate				5-20
Tris-2-butoxyethyl phosphate		2-8		5-20
Caprolactam		2-8	20-80	12-50
Tributylphosphate	2-6			
Iodoacetone			Present	
Quinone			2-8	
2-Butoxyethanol				2-8
Benzothiazole				2-8
An Amine MW=171				1-4
Hexadecanoic acid		1-4		2-6
Organic acids (not fatty)	100-400			
Xylenes	2-8		6-25	
C_3 substituted benzenes	2-8		3-10	
Styrene			5-20	
Alkyl benzenes			5-20	4-16
Hexadecane				2-6
Octadecane				0.5-2
Nonadecane				1-4
Eicosane				1-4
Heneicosane				0.5-2
Phytane				0.5-2
A cyclohexyl paraffin		0.5-2		
Phenyl paraffins		3-10		
Paraffin oil C_{20}-C_{40}		100-400		250-1000

Table F-9 (continued)

Pesticides Screened in Base/Neutral Extracts	Detection Limit	M-2	M-6	M-9	GC-1
alpha-BHC	*				
gamma-BHC	*				
beta-BHC	3	ND	ND	ND	ND
Heptachlor	3	ND	ND	ND	ND
delta-BHC	3	ND	ND	ND	ND
Aldrin	3	ND	ND	ND	ND
Heptachlor epoxide	3	ND	ND	ND	ND
Endosulfan I	*				
Dieldrin	4	ND	ND	ND	ND
4,4'-DDE	3	ND	ND	ND	ND
Endrin	*				
Endosulfan II	*				
4,4'-DDD	3	ND	ND	ND	ND
4,4'-DDT	5	ND	ND	ND	ND
Endosulfan sulfate	5	ND	ND	ND	ND
Chlordane	*				
Toxaphene	*				

Acid Extractable Compound	Detection Limit	M-2	M-6	M-9	GC-1
2-Chlorophenol	2	ND	ND	ND	ND
2-Nitrophenol	2	ND	ND	3	ND
Phenol	1	12	1	4	1
2,4-Dimethylphenol	1	8	ND	ND	ND
2,4-Dichlorophenol	2	ND	ND	ND	ND
2,4,6-Trichlorophenol	2	ND	ND	ND	ND
4-Chloro-3-methylphenol	2	ND	ND	ND	ND
2,4-Dinitrophenol	30	ND	ND	ND	ND
2-Methyl-4,6-dinitrophenol	20	ND	ND	ND	ND
Pentachlorophenol	3	ND	ND	ND	ND
4-Nitrophenol	10	ND	ND	ND	ND

Additional Compounds

Methyl phenol		Present
C_3 substituted phenols		4-16

* Compound is decomposed by the extraction process.
**Compound decomposes in the injection port of the GC.

Table F-10

Summary of GC/MS Analysis of Water Samples
from Berman Pond (Winter 1982-83)
(micrograms per liter)

Purgeable Compound	Detection Limit	BPM-1	BPM-2
Chloromethane	320	ND	ND
Bromomethane	90	ND	ND
Vinyl Chloride	420	ND	ND
Chloroethane	90	ND	ND
Dichloromethane	8	ND	ND
Trichlorofluoromethane	8	ND	ND
1,1-Dichloroethene	8	ND	ND
1,1-Dichloroethane	8	ND	13
trans-1,2-Dichloroethene	8	ND	ND
Chloroform	8	ND	ND
1,2-Dichloroethane	8	ND	ND
1,1,1-Trichloroethane	8	ND	15
Carbon tetrachloride	8	ND	ND
Bromodichloromethane	8	ND	ND
1,2-Dichloropropane	8	ND	ND
trans-1,3-Dichloropropene	8	ND	ND
Trichloroethene	8	ND	ND
Dibromochloromethane	8	ND	ND
1,1,2-Trichloroethane	8	ND	ND
cis-1,3-Dichloropropene	8	ND	ND
Benzene	8	ND	ND
2-Chloroethylvinyl ether	8	ND	ND
Bromoform	8	ND	ND
1,1,2,2-Tetrachloroethane	8	ND	ND
Tetrachloroethene	8	ND	ND
Toluene	8	ND	ND
Chlorobenzene	8	ND	ND
Ethylbenzene	8	ND	ND
Acrolein	8	ND	ND
Acrylonitrile	8	ND	ND
Additional Purgeable Compounds			
Dichlorobenzenes	8	ND	15-60

Table F-10 (continued)

Base/Neutral Extractable Compound	Detection Limit	BPM-1	BPM-2
1,3-Dichlorobenzene	1	ND	1
1,4-Dichlorobenzene	1	ND	16
Hexachloroethane	3	ND	ND
Bis(2-chloroethyl)ether	5	ND	ND
1,2-Dichlorobenzene	1	ND	2
Bis(2-chloroisopropyl)ether	3	ND	ND
N-nitroso-di-n-propyl amine	15	ND	ND
Nitrobenzene	8	ND	ND
Hexachlorobutadiene	1	ND	ND
1,2,4-Trichlorobenzene	1	ND	2
Isophorone	3	ND	ND
Naphthalene	3	ND	ND
Bis(chloroethoxy)methane	6	ND	ND
Hexachlorocyclopentadiene	*	ND	ND
2-Chloronaphthalene	2	ND	ND
Acenaphthylene	3	ND	ND
Acenaphthene	3	ND	ND
Dimethyl phthalate	1	ND	ND
2,6-Dinitrotoluene	5	ND	ND
Fluorene	2	ND	ND
4-Chlorophenyl phenyl ether	3	ND	ND
2,4-Dinitrotoluene	12	ND	ND
Diethyl phthalate	1	ND	ND
N-nitrosodiphenyl amine	**	ND	ND
Hexachlorobenzene	3	ND	ND
4-Bromophenyl phenyl ether	2	ND	ND
Phenanthrene	3	ND	ND
Anthracene	3	ND	ND
Di-n-butyl phthalate	1	2	1
Fluoranthene	3	ND	ND
Pyrene	3	ND	ND
Benzidine	*	ND	ND
Butyl benzyl phthalate	7	ND	ND
Bis(2-ethylhexyl)phthalate	1	16	3
Chrysene	10	ND	ND
Benzo(a)anthracene	5	ND	ND
3,3'-Dichlorobenzidine	10	ND	ND
Di-n-octyl phthalate	3	3	4
Benzo(b)fluoranthene	1	ND	ND
Benzo(k)fluoranthene	5	ND	ND
Benzo(a)pyrene	3	ND	ND
Indeno(1,2,3-c,d)pyrene	3	ND	ND
Dibenzo(a,h)anthracene	5	ND	ND
Benzo(g,h,i)perylene	8	ND	ND
N-nitrosodimethylamine	**	ND	ND

Table F-10 (continued)

Additional Base/Neutral Compounds	BPM-1	BPM-2
2,2,4-Trimethyl-1,3-pentane diol-di-isobutyrate	5-20	1-4
Tris-2-butoxyethyl phosphate	3-12	3-10
Caprolactam	10-40	4-14
$C_5H_8Cl_2$	1-4	
2-Ethylhexanoic acid	7-28	2-6
Hexadecanoic acid	1-4	
Xylenes	5-20	
Decane	1-4	
Hexadecane	1-4	
Heptadecane	0.5-2	
Pristane	0.5-2	
Octadecane	1-4	
Phytane	0.5-2	
Nonadecane	2-6	
Eicosane	1-4	
Heneicosane	1-4	
Paraffin oil	150-700	

Table F-10 (continued)

Pesticides Screened in Base/Neutral Extracts	Detection Limit	BPM-1	BPM-2
alpha-BHC	*		
gamma-BHC	*		
beta-BHC	3	ND	ND
Heptachlor	3	ND	ND
delta-BHC	3	ND	ND
Aldrin	3	ND	ND
Heptachlor epoxide	3	ND	ND
Endosulfan I	*		
Dieldrin	4	ND	ND
4,4'-DDE	3	ND	ND
Endrin	*		
Endosulfan II	*		
4,4'-DDD	3	ND	ND
4,4'-DDT	5	ND	ND
Endosulfan sulfate	5	ND	ND
Chlordane	*		
Toxaphene	*		

Acid Extractable Compound	Detection Limit	BPM-1	BPM-2
2-Chlorophenol	2	ND	ND
2-Nitrophenol	2	ND	ND
Phenol	1	1	1
2,4-Dimethylphenol	1	ND	ND
2,4-Dichlorophenol	2	ND	ND
2,4,6-Trichlorophenol	2	ND	ND
4-Chloro-3-methylphenol	2	ND	ND
2,4-Dinitrophenol	30	ND	ND
2-Methyl-4,6-dinitrophenol	20	ND	ND
Pentachlorophenol	3	ND	ND
4-Nitrophenol	10	ND	ND
Additional Compounds			
1,1,3,3-Tetramethylbutylphenol (or similar)			2-8

* Compound is decomposed by the extraction process.
**Compound decomposes in the injection port of the GC.

Table F-11

The complete report of the GC/MS analysis of water samples from Base Well No. 4 is included as Table F-11.

March 7, 1983

ANALYTICAL REPORT

UBTL
520 WAKARA WAY
SALT LAKE CITY,
UTAH 84108
801 581-8267

SUBMITTED TO: Project Manager, Hill Air Force Base

SUBMITTED BY: Richard Wade

REFERENCE DATA:

Analysis of: Organic Purgeables

Identification No.: Base Well #4

Sample(s): 1 Analyses:

UBTL Laboratory No.: SA 1378

The sample indicated above was analyzed following EPA Method 624 as described in the "Guidelines Establishing Test Procedures for the Analysis of Pollutants," Fed. Reg., 3 December 1979.

The water sample was purged with helium for 11 minutes onto a 10 inch x 1/8 inch I.D. steel trap packed with 2/3 Tenax and 1/3 silica gel. The purge rate was set at 40 mL/min. A Tekmar Liquid Sample Concentrator and a Tekmar Automatic Liquid Sampler were used in combination to accomplish this portion of the analysis.

A separation of the compounds of interest was obtained with a six foot glass column (packed with 1% SP-1000 on 60/80 mesh Carbopak B) and temperature programming from 45°C after 2 minutes to 220°C.

The analysis of the sample was accomplished using a Finnigan OWA 1020 GC-MC system. The mass spectrometer scanned a range of 33 to 260 AMU every 2 seconds. Fourteen hundred scans were acquired for each sample.

None of the compounds listed in the method were found above the limits of detection. The sample was also screened for other compounds in addition to those listed in the method; however, no significant peaks were observed in the chromatogram of the sample.

The results are tabulated on the following page(s).

Richard Wade
Richard Wade

Sim D. Lonsley for
Rand Potter

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RESEARCH INSTITUTE

MEDICINE
BIOENGINEERING
CHEMISTRY

RESEARCH
DEVELOPMENT
ANALYSIS

March 8, 1983

UBTL
520 WAKARA WAY
SALT LAKE CITY,
UTAH 84108
801 581-8267

ANALYTICAL REPORT

SUBMITTED TO: Hill AFB Survey

SUBMITTED BY: John M. Reynolds

REFERENCE DATA:

Analysis of: EPA Method 625 GC/MS

Identification No.: Base Well #4

Sample(s): 1 Analyses:

UBTL Laboratory No.: SA-1378

The sample was extracted by EPA method 625 for base/neutral and acid priority pollutants. Acid and base/neutral extracts were kept separate and concentrated in chloroform to 1 mL. Analysis was performed on an HP-5985 GC/MS using the EPA protocol modified for capillary column separation. The column was a fused silica solumn, 0.32 mm i.d. x 26 meter, having a 1 micron thick layer of SE-54 bonded internally ("DB5" from J. and W. Scientific). Carrier gas was helium at a head pressure of p.s.i. (average flow rate was about 2 cc/min.). The column was temperature programmed from 70°C (for 2 min.) to 300°C at 10°C/min. Injection volume was 3.3 µL. Injection mode was splitless with the split valve off for 1 minute after injection. The column was direct coupled to the mass analyzer which was operated in the electron impact mode (70 eV) and scanned from 33 to 483 AMU at 800 AMU/sec.

The data from each sample was computer processed first to detect and quantitate any of the EPA priority pollutants and secondly to identify significant GC peaks not also present in the blanks.

The only base/neutral compounds found were phthalate plasticizers:

Diethyl phthalate	10. µg/L
Di-(2-ethyl hexyl)-phthalate	11. µg/L

The limit of detection for the acids and base/neutrals was better than 10 µg/L for all analytes tested. There were no EPA acidic priority pollutants detected.

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ANALYSIS

In the identification of significant GC peaks (those at least greater than about 10% of the height of an internal standard at 20 µg/), none were found in the acid fraction. In the base neutra fraction there was 2,6-di-tert-butyl phenol (between 20 and 50 µg/L approximately) and an oil consisting of numerous poorly resolved GC peaks. The oil was composed of normal, branched, and cyclic paraffins mostly between the carbon numbers of C20 and C40.

John M. Reynolds

John M. Reynolds

Sim D. Lessley

Sim D. Lessley, Ph.D.

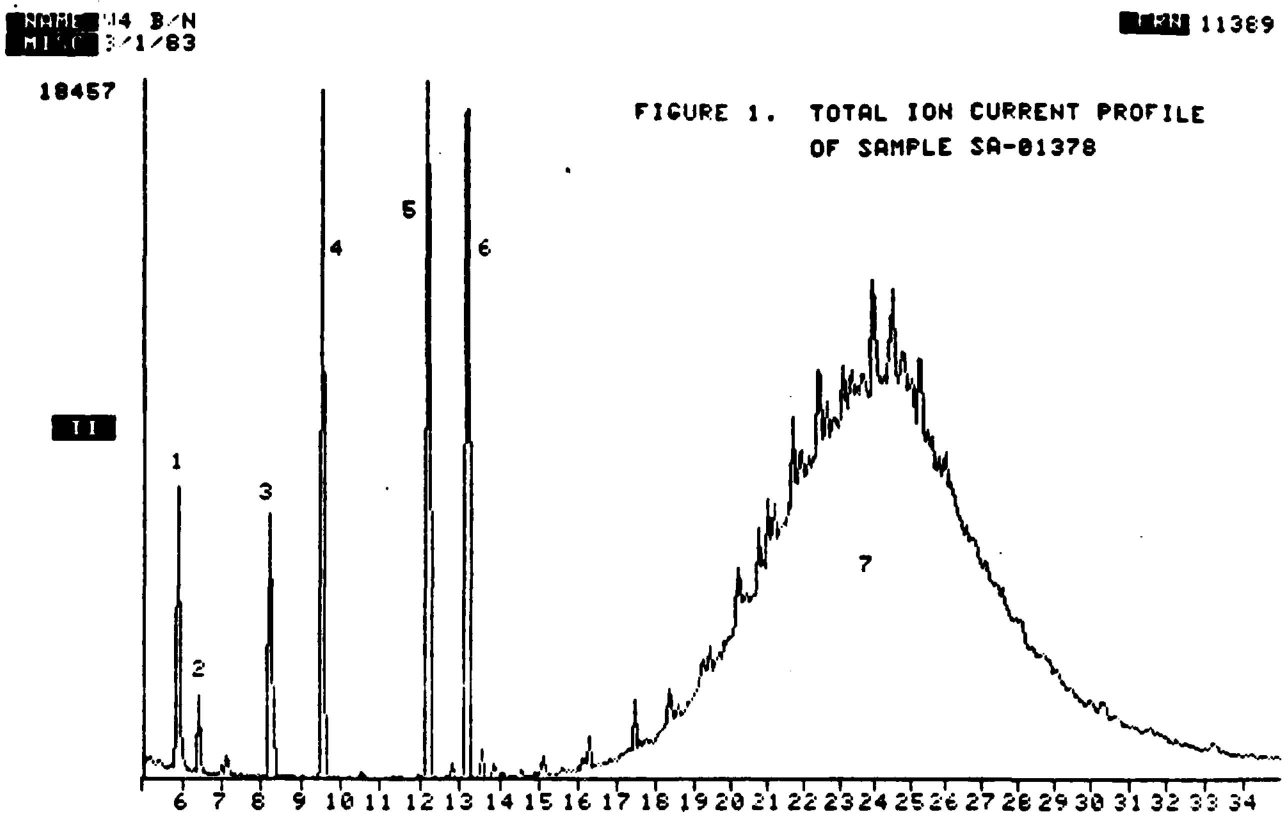


FIGURE 1. TOTAL ION CURRENT PROFILE OF SAMPLE SA-01378

TABLE 1. IDENTITY AND RELATIVE PEAK AREAS OF SIGNIFICANT GC PEAKS IN SAMPLE SA-01378

Entry	Time	Area	%		IDENTITY
1	5.9	31968.	104.7		D6-PHENOL (INT STD)
2	6.4	8491.	27.8		4-FLUOROANILINE (SUR. STD)
3	8.3	30528.	100.0	**	DECAFLUOROBIPHENYL (INT STD)
4	9.5	67128.	219.9		1-FLUORONAPHTHALENE (SUR. STD)
5	12.2	78090.	255.8		2-FLUOROBIPHENYL (INT STD)
6	13.1	77214.	252.9		2,6-DI-tert-BUTYL PHENOL
7	15 to 30	6988438.	22891.7		A PARAFFINIC OIL.

** DECAFLUOROBIPHENYL INTERNAL STANDARD WAS 20UG/L. RELATIVE CONCENTRATIONS OF OTHER COMPOUNDS ARE NOT DIRECTLY PROPORTIONAL TO THE INTERNAL STANDARD DUE TO DIFFERING RELATIVE RESPONSES.

Table F-12

Summary of Second Episode of Water Sample Analyses (May 1983) for Chemical Disposal Pits No. 1 & 2

Analysis	Units	M-1	M-2	M-3	M-4
TOC	mg/L	20	43	2	10
O&G	mg/L	<5	<5	<5	<5
Phenol	μg/L	150	920	<10	40
TDS	mg/L	--	670	380	--
Sulfate	mg/L	--	<5	42	--
Barium	μg/L	<100	<100	<100	<100
Cadmium	μg/L	<10	10	<10	<10
Iron	μg/L	1,900	2,300	<100	100
Manganese	μg/L	370	1,600	140	850
Zinc	μg/L	320	270	200	270
Conductance	μmho/cm	740	960	580	730
Calcium	mg/L	100	170	59	110
Magnesium	mg/L	29	26	28	29
Sodium	mg/L	--	27	43	--
Potassium	mg/L	--	4	8	--
Carbonate	mg/L	--	44	21	--
Bicarbonate	mg/L	--	440	220	--
Chloride	mg/L	--	56	46	--
Fluoride	mg/L	--	0.2	0.3	--
Nitrate	mg/L	--	0.03	<0.02	--
Hardness	mg/L	--	530	260	--
Silica	mg/L	--	26	15	--

"--" Denotes an analysis which was not specified for the sample

Table F-12 (continued)

Analysis EPA 601	Units	M-1	M-2	M-3	M-4
Methylene Chloride	µg/L	2	<1	<1	<1
1,1,1-Trichloroethane	µg/L	3	26,000	<1	57
Carbon Tetrachloride	µg/L	<1	92	5	110
Trichloroethene	µg/L	<1	33	<1	<1
1,1,2-Trichloroethane	µg/L	<1	<1	<1	<1
1,1,2,2-Tetrachloroethane	µg/L	<1	<1	<1	<1
Chloromethane	µg/L	<1	<1	<1	<1
Bromomethane	µg/L	<1	<1	<1	<1
Dichlorodifluoromethane	µg/L	<1	<1	<1	<1
Vinyl Chloride	µg/L	<1	<1	<1	<1
Chloroethane	µg/L	<1	<1	<1	<1
Trichlorofluoromethane	µg/L	<1	56	<1	<1
1,1-Dichloroethene	µg/L	<1	110	<1	9
1,1-Dichloroethane	µg/L	35	<1	<1	4,300
trans-1,2-Dichloroethene	µg/L	410	34,000	350	<1
Chloroform	µg/L	<1	<1	<1	<1
1,2-Dichloroethane	µg/L	33	<1	<1	<1
Bromodichloromethane	µg/L	<1	<1	<1	<1
1,2-Dichloropropane	µg/L	<1	41	<1	<1
trans-1,3-Dichloropropene	µg/L	<1	<1	<1	<1
Dibromochloromethane	µg/L	<1	<1	<1	<1
cis-1,3-Dichloropropene	µg/L	<1	<1	<1	<1
2-Chloroethylvinyl ether	µg/L	<1	<1	<1	<1
Bromoform	µg/L	<1	<1	<1	<1
Tetrachloroethene	µg/L	<5	190	<5	25
Chlorobenzene	µg/L	850	11	<1	<1
1,3-Dichlorobenzene	µg/L	<5	<5	<5	<5
1,2-Dichlorobenzene	µg/L	950	890	<5	17
1,4-Dichlorobenzene	µg/L	<5	<5	<5	<5
EPA 602					
Benzene	µg/L	82	14,000	62	1,700
Toluene	µg/L	5	580	<1	7
Ethyl benzene	µg/L	3	15	<1	<1
m-Xylene	µg/L	<1	<10	<1	7
p-Xylene	µg/L	<1	10	<1	<1
o-Xylene	µg/L	69	64	<1	<1

Table F-13

Summary of Second Episode of Water Sample Analyses (May 1983) for Landfill No. 3

Analysis	Units	M-6	M-7	M-9	M-10	W-7	W-8
TOC	mg/L	10	2	13	1	3	2
O&G	mg/L	<5	<5	<5	<5	<5	<5
Phenol	µg/L	10	50	40	<10	<10	<10
MBAS	mg/L	<0.1	<0.1	0.3	<0.1	<0.1	<0.1
TDS	mg/L	370	480	2,600	810	320	480
Cyanide	µg/L	<10	<10	<10	<10	<10	<10
Sulfate	mg/L	41	39	460	88	21	40
Arsenic	µg/L	8	<5	28	9	<5	<5
Barium	µg/L	<100	<100	<100	<100	<100	<100
Beryllium	µg/L	<10	<10	<10	<10	<10	<10
Cadmium	µg/L	<10	<10	10	<10	<10	<10
Chromium	µg/L	<50	<50	<50	<50	<50	<50
Copper	µg/L	<20	<20	<20	<20	<20	<20
Iron	µg/L	<100	<100	<100	100	<100	<100
Lead	µg/L	<10	<10	<10	<10	<10	<10
Manganese	µg/L	220	<20	1,700	320	<20	20
Mercury	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Zinc	µg/L	80	90	80	30	30	30
Conductance	µmho/cm	560	700	3,600	1,000	390	680
Calcium	mg/L	58	90	280	110	86	99
Magnesium	mg/L	30	30	130	64	12	24
Sodium	mg/L	38	55	490	79	--	--
Potassium	mg/L	7	2	19	13	--	--
Carbonate	mg/L	20	68	17	22	--	--
Bicarbonate	mg/L	220	240	460	290	--	--
Chloride	mg/L	48	58	910	200	--	--
Fluoride	mg/L	0.4	0.5	0.3	0.3	--	--
Nitrate	mg/L	<0.02	2.1	0.04	0.28	--	--
Hardness	mg/L	270	350	1,200	540	--	--
Silica	mg/L	10	16	16	13	--	--

"--" Denotes an analysis which was not specified for the sample

Table F-13 (continued)

Analysis EPA 601	Units	M-6	M-7	M-9	M-10	W-7	W-8
Methylene Chloride	µg/L	<1	<1	3	<1	<1	<1
1,1,1-Trichloroethane	µg/L	<1	<1	<1	<1	3	16
Carbon Tetrachloride	µg/L	<1	<1	<1	<1	<1	<1
Trichloroethene	µg/L	<1	1	52	<1	<1	3
1,1,2-Trichloroethane	µg/L	<1	<1	<1	<1	<1	<1
1,1,2,2-Tetrachloroethane	µg/L	<1	<1	<1	<1	<1	<1
Chloromethane	µg/L	<1	<1	<1	<1	<1	<1
Bromomethane	µg/L	<1	<1	<1	<1	<1	<1
Dichlorodifluoromethane	µg/L	<1	<1	<1	<1	<1	<1
Vinyl Chloride	µg/L	<1	<1	<1	<1	<1	<1
Chloroethane	µg/L	<1	<1	<1	<1	<1	<1
Trichlorofluoromethane	µg/L	<1	<1	<1	<1	<1	<1
1,1-Dichloroethene	µg/L	<1	<1	2	<1	<1	<1
1,1-Dichloroethane	µg/L	<1	<1	6	<1	<1	3
trans-1,2-Dichloroethene	µg/L	<1	<1	<1	<1	4	8
Chloroform	µg/L	<1	<1	<1	<1	<1	<1
1,2-Dichloroethane	µg/L	<1	<1	16	<1	<1	<1
Bromodichloromethane	µg/L	<1	<1	<1	<1	<1	<1
1,2-Dichloropropane	µg/L	<1	<1	<1	<1	<1	<1
trans-1,3-Dichloropropene	µg/L	<1	<1	<1	<1	<1	<1
Dibromochloromethane	µg/L	<1	<1	<1	<1	<1	<1
cis-1,3-Dichloropropene	µg/L	<1	<1	<1	<1	<1	<1
2-Chloroethylvinyl ether	µg/L	<1	<1	<1	<1	<1	<1
Bromoform	µg/L	<1	<1	<1	<1	<1	<1
Tetrachloroethene	µg/L	<5	<5	<5	<5	<5	<5
Chlorobenzene	µg/L	<1	<1	14	<1	<1	<1
1,3-Dichlorobenzene	µg/L	<5	<5	<5	<5	<5	<5
1,2-Dichlorobenzene	µg/L	<5	<5	490	7	<5	<5
1,4-Dichlorobenzene	µg/L	<5	<5	<5	<5	<5	<5
EPA 602							
Benzene	µg/L	<1	<1	37	<1	<1	1
Toluene	µg/L	<1	<1	<1	<1	<1	<1
Ethyl benzene	µg/L	<1	<1	<1	<1	<1	<1
m-Xylene	µg/L	<1	<1	<1	<1	<1	<1
p-Xylene	µg/L	<1	<1	<1	<1	<1	<1
o-Xylene	µg/l	<1	<1	<1	<1	<1	<1

Table F-14

Summary of Second Episode of Water Sample Analyses (May 1983) for Golf Course Area

Analysis	Units	GC-1	80-19	W-13	W-13A	GC-Lot Grab
TOC	mg/L	2	--	--	--	--
O&G	mg/L	<5	--	--	--	--
Phenol	µg/L	390	--	--	--	--
MBAS	mg/L	<0.1	--	--	--	--
TDS	mg/L	620	730	630	1000	80
Cyanide	µg/L	<10	--	--	--	--
Sulfate	mg/L	88	75	110	130	8
Arsenic	µg/L	<5	--	--	--	--
Barium	µg/L	<100	<100	<100	<100	<100
Beryllium	µg/L	<10	--	--	--	--
Cadmium	µg/L	<10	<10	<10	<10	--
Chromium	µg/L	<50	--	--	--	--
Copper	µg/L	<20	--	--	--	--
Iron	µg/L	<100	<100	<100	<100	200
Lead	µg/L	<10	--	--	--	--
Manganese	µg/L	250	<20	360	270	<20
Mercury	µg/L	<0.2	--	--	--	--
Zinc	µg/L	50	230	100	30	50
Conductance	µmho/cm	900	1000	920	1500	100
Calcium	mg/L	20	97	100	84	10
Magnesium	mg/L	43	42	37	51	1
Sodium	mg/L	140	110	66	200	13
Potassium	mg/L	24	6	6	10	<1
Carbonate	mg/L	52	23	16	28	10
Bicarbonate	mg/L	320	360	360	470	20
Chloride	mg/L	66	130	60	170	14
Fluoride	mg/L	1.3	0.5	0.5	0.7	0.2
Nitrate	mg/L	2.0	2.8	0.5	2.7	0.57
Hardness	mg/L	230	420	400	420	29
Silica	mg/L	5	14	16	16	2

"--" Denotes an analysis which was not specified for the sample

Table F-14 (continued)

Analysis

EPA 601	Units	GC-1	80-19	W-13	W-13A	GC-Lot Grab
Methylene Chloride	μg/L	<1	--	--	--	--
1,1,1-Trichloroethane	μg/L	<1	--	--	--	--
Carbon Tetrachloride	μg/L	<1	--	--	--	--
Trichloroethene	μg/L	<1	--	--	--	--
1,1,2-Trichloroethane	μg/L	<1	--	--	--	--
1,1,2,2-Tetrachloroethane	μg/L	<1	--	--	--	--
Chloromethane	μg/L	<1	--	--	--	--
Bromomethane	μg/L	<1	--	--	--	--
Dichlorodifluoromethane	μg/L	<1	--	--	--	--
Vinyl Chloride	μg/L	<1	--	--	--	--
Chloroethane	μg/L	<1	--	--	--	--
Trichlorofluoromethane	μg/L	<1	--	--	--	--
1,1-Dichloroethene	μg/L	<1	--	--	--	--
1,1-Dichloroethane	μg/L	<1	--	--	--	--
trans-1,2-Dichloroethene	μg/L	<1	--	--	--	--
Chloroform	μg/L	<1	--	--	--	--
1,2-Dichloroethane	μg/L	<1	--	--	--	--
Bromodichloromethane	μg/L	<1	--	--	--	--
1,2-Dichloropropane	μg/L	<1	--	--	--	--
trans-1,3-Dichloropropene	μg/L	<1	--	--	--	--
Dibromochloromethane	μg/L	<1	--	--	--	--
cis-1,3-Dichloropropene	μg/L	<1	--	--	--	--
2-Chloroethylvinyl ether	μg/L	<1	--	--	--	--
Bromoform	μg/L	<1	--	--	--	--
Tetrachloroethene	μg/L	<5	--	--	--	--
Chlorobenzene	μg/L	<1	--	--	--	--
1,3-Dichlorobenzene	μg/L	<5	--	--	--	--
1,2-Dichlorobenzene	μg/L	<5	--	--	--	--
1,4-Dichlorobenzene	μg/L	<5	--	--	--	--
EPA 602						
Benzene	μg/L	<1	--	--	--	--
Toluene	μg/L	<1	--	--	--	--
Ethyl benzene	μg/L	<1	--	--	--	--
m-Xylene	μg/L	<1	--	--	--	--
p-Xylene	μg/L	<1	--	--	--	--
o-Xylene	μg/l	<1	--	--	--	--

"--"Denotes an analysis which was not specified for the sample

Table F-15

Summary of Second Episode of Water Sample Analyses (May 1983)
for Berman Pond

Analysis	Units	BPM-1	BPM-2	BPL-1	BPL-2	BPL-3	BPL-4
TOC	mg/L	4	2	6	4	*	14
O&G	mg/L	<5	<5	*	<5	*	*
Phenol	µg/L	<10	10	*	<10	*	*
Cyanide	µg/L	<10	<10	*	<10	*	*
Barium	µg/L	<100	<100	<100	<100	*	<100
Beryllium	µg/L	<10	<10	<10	<10	*	<10
Cadmium	µg/L	<10	<10	<10	<10	*	<10
Chromium	µg/L	<50	<50	<50	<50	*	<50
Iron	µg/L	<100	<100	<100	<100	*	<100
Manganese	µg/L	50	70	<20	<20	*	<20
Zinc	µg/L	<10	<10	30	<10	*	40
Conductance	µmho/cm	250	450	460	530	*	640
Calcium	mg/L	18	25	77	100	*	110
Magnesium	mg/L	11	8	9	7	*	14

"*" Denotes a sample which could not be collected

Table F-15 (continued)

Analysis EPA 601	Units	BMP-1	BPM-2	BPL-1	BPL-2	BPL-3	BPL-4
Methylene Chloride	μg/L	<1	<1	<1	<1	*	*
1,1,1-Trichloroethane	μg/L	<1	4	160	1	*	*
Carbon Tetrachloride	μg/L	<1	<1	<1	<1	*	*
Trichloroethene	μg/L	<1	<1	1400	6	*	*
1,1,2-Trichloroethane	μg/L	<1	<1	<1	<1	*	*
1,1,2,2-Tetrachloroethane	μg/L	<1	<1	<1	<1	*	*
Chloromethane	μg/L	<1	<1	<1	<1	*	*
Bromomethane	μg/L	<1	<1	<1	<1	*	*
Dichlorodifluoromethane	μg/L	<1	<1	<1	<1	*	*
Vinyl Chloride	μg/L	<1	<1	<1	<1	*	*
Chloroethane	μg/L	<1	<1	<1	<1	*	*
Trichlorofluoromethane	μg/L	<1	<1	<1	<1	*	*
1,1-Dichloroethene	μg/L	<1	2	59	<1	*	*
1,1-Dichloroethane	μg/L	<1	12	<1	<1	*	*
trans-1,2-Dichloroethene	μg/L	<1	<1	<1	<1	*	*
Chloroform	μg/L	<1	<1	<1	<1	*	*
1,2-Dichloroethane	μg/L	<1	<1	<1	<1	*	*
Bromodichloromethane	μg/L	<1	<1	<1	<1	*	*
1,2-Dichloropropane	μg/L	<1	<1	<1	<1	*	*
trans-1,3-Dichloropropene	μg/L	<1	<1	<1	<1	*	*
Dibromochloromethane	μg/L	<1	<1	<1	<1	*	*
cis-1,3-Dichloropropene	μg/L	<1	<1	<1	<1	*	*
2-Chloroethylvinyl ether	μg/L	<1	<1	<1	<1	*	*
Bromoform	μg/L	<1	<1	<1	<1	*	*
Tetrachloroethene	μg/L	<5	<5	200	<5	*	*
Chlorobenzene	μg/L	<1	2	<1	<1	*	*
1,3-Dichlorobenzene	μg/L	<5	<5	<5	<5	*	*
1,2-Dichlorobenzene	μg/L	<5	38	<5	<5	*	*
1,4-Dichlorobenzene	μg/L	<5	<5	<5	<5	*	*
EPA 602							
Benzene	μg/L	<1	<1	<1	<1	*	*
Toluene	μg/L	<1	<1	2	1	*	*
Ethyl benzene	μg/L	<1	<1	<1	<1	*	*
m-Xylene	μg/L	<1	<1	<1	<1	*	*
p-Xylene	μg/L	<1	<1	<1	<1	*	*
o-Xylene	μg/1	<1	<1	<1	<1	*	*

"*"Denotes a sample which could not be collected

Table F-16

Summary of Second Episode of Water Sample Analyses for Chemical Disposal Pit No. 3 (May 1983)

Analysis	Unit	P-1	P-2	P-3	P-4	P-5	P-6	P-7	P-8	P-9	P-10	CP3L-1	CP3L-2	CP3L-3
TOC	mg/L	100	44	130	2	17	180	13	43	18	99	8	5	11
Phenol	µg/L	<10	<10	20	10	60	15,300	40	<10	10	720	-	-	-
Cyanide	µg/L	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Barium	µg/L	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Beryllium	µg/L	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Cadmium	µg/L	<10	<10	<10	<10	<10	100	<10	<10	<10	50	<10	10	<10
Chromium	µg/L	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Iron	µg/L	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Manganese	µg/L	150	90	420	<20	20	2,400	160	350	<20	700	<20	<20	<20
Zinc	µg/L	70	40	50	230	30	540	240	200	50	280	<10	<10	<10
Conduct.	µmho/cm	3,300	920	950	950	820	1,200	1,000	650	640	1,200	400	1,200	350
Calcium	mg/L	280	40	87	91	13	100	89	60	80	160	87	75	47
Magnesium	mg/L	130	35	51	42	20	60	51	34	29	53	9	94	35

* Denotes a sample which could not be collected.
"-" Denotes an analysis which was not specified for the sample.

Table F-16 (continued)

Analysis EPA 601	Unit	P-1	P-2	P-3	P-4	P-5	P-6	P-7	P-8	P-9	P-10	CP3L-1	CP3L-2	CP3L-3
Methylene Chloride	µg/L	<100	2	<100	<100	<1	63,000	<10,000	<50	<50	34,000	<1	<100	1,900
1,1,1-Trichloroethane	µg/L	770	56	<100	<100	<1	240,000	<10,000	56	68	77,000	710	290	24,000
Carbon Tetrachloride	µg/L	<100	<1	<100	<100	<1	<10,000	<10,000	<50	<50	<10,000	<1	<100	<100
Trichloroethene	µg/L	6,200	360	4,000	1,400	2	1,100,000	1,400,000	1,700	1,700	610,000	3,700	14,000	30,000
1,1,2-Trichloroethane	µg/L	<100	<1	<100	<100	<1	<10,000	<10,000	<50	<50	10,000	<1	<100	<100
1,1,2,2-Tetrachloroethane	µg/L	<100	<1	<100	<100	<1	<10,000	<10,000	<50	<50	<10,000	<1	<100	<100
Chloromethane	µg/L	<100	<1	<100	<100	<1	<10,000	<10,000	<50	<50	<10,000	<1	<100	<100
Bromomethane	µg/L	<100	<1	<100	<100	<1	<10,000	<10,000	<50	<50	<10,000	<1	<100	<100
Dichlorodifluoromethane	µg/L	<100	<1	<100	<100	<1	<10,000	<10,000	<50	<50	<10,000	<1	<100	<100
Vinyl Chloride	µg/L	<100	<1	<100	<100	<1	<10,000	<10,000	<50	<50	<10,000	<1	<100	<100
Chloroethane	µg/L	<100	<1	<100	<100	<1	<10,000	<10,000	<50	<50	<10,000	<1	<100	<100
Trichlorofluoromethane	µg/L	<100	<1	<100	<100	<1	<10,000	<10,000	<50	<50	<10,000	<1	<100	<100
1,1-Dichloroethene	µg/L	<100	4	<100	<100	<1	16,000	<10,000	<50	<50	<10,000	97	<100	1,800
1,1-Dichloroethane	µg/L	<100	34	<100	<100	<1	<10,000	<10,000	<50	<50	<10,000	<1	<100	<100
trans-1,2-Dichloroethene	µg/L	<100	<1	<100	<100	<1	<10,000	<10,000	<50	<50	<10,000	<1	<100	<100
Chloroform	µg/L	130	<1	<100	<100	<1	<10,000	<10,000	<50	53	<10,000	<1	<100	160
1,2-Dichloroethane	µg/L	<100	<1	<100	<100	<1	16,000	<10,000	<50	<50	<10,000	11	<100	240
Bromodichloromethane	µg/L	<100	<1	<100	<100	<1	<10,000	<10,000	<50	<50	<10,000	<1	<100	<100
1,2-Dichloropropane	µg/L	<100	<1	<100	<100	<1	<10,000	<10,000	<50	<50	<10,000	<1	<100	<100
trans-1,3-Dichloropropene	µg/L	<100	<1	<100	<100	<1	<10,000	<10,000	<50	<50	<10,000	<1	<100	<100
Dibromochloromethane	µg/L	<100	<1	<100	<100	<1	<10,000	<10,000	<50	<50	<10,000	<1	<100	<100
cis-1,3-Dichloropropene	µg/L	<100	<1	<100	<100	<1	<10,000	<10,000	<50	<50	<10,000	<1	<100	<100
2-Chloroethylvinyl Ether	µg/L	<100	<1	<100	<100	<1	<10,000	<10,000	<50	<50	<10,000	<1	<100	<100
Bromoform	µg/L	<100	<1	<100	<100	<1	<10,000	<10,000	<50	<50	<10,000	<1	<100	<100
Tetrachloroethene	µg/L	<500	<5	<500	<500	<5	<50,000	<50,000	<250	<250	52,000	210	<500	860
Chlorobenzene	µg/L	<100	<1	<100	<100	<1	<10,000	<10,000	<50	<50	<10,000	<1	<100	<100
1,3-Dichlorobenzene	µg/L	<500	<5	<500	<500	<5	<50,000	<50,000	<250	<250	<50,000	<5	<500	<500
1,2-Dichlorobenzene	µg/L	<500	<5	<500	<500	<5	<50,000	<50,000	<250	<250	<50,000	<5	<500	<500
1,4-Dichlorobenzene	µg/L	<500	<5	<500	<500	<5	<50,000	<50,000	<250	<250	<50,000	<5	<500	<500

APPENDIX G: GEOPHYSICAL DATA

(pp. G-1 through G-58

(Continued)

(Continued)

APPENDIX G: GEOPHYSICAL DATA

(pp. G-1 through G-58

(Continued)

(Continued)

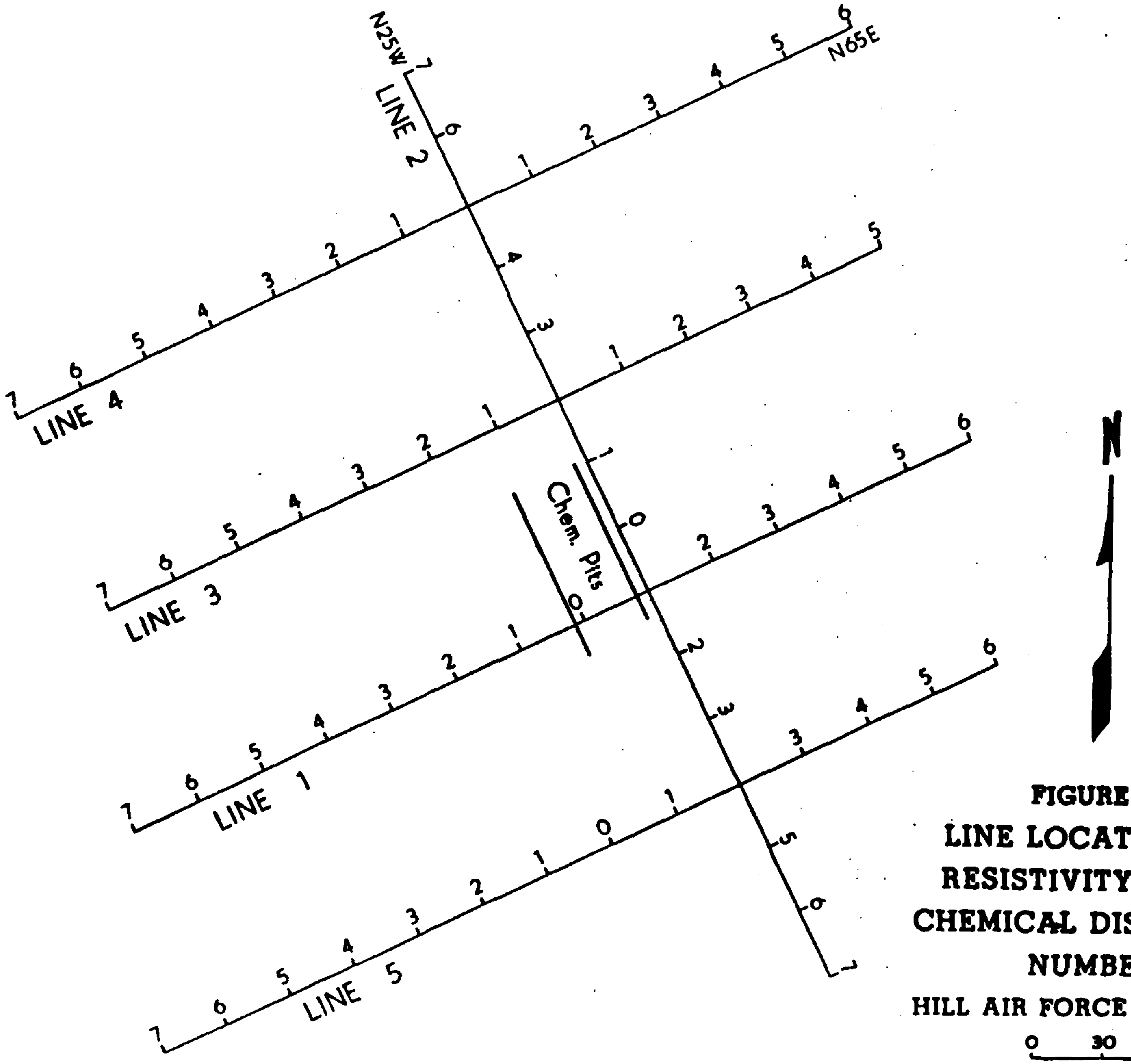
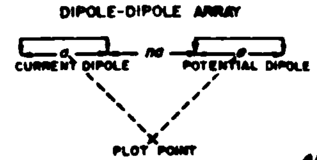


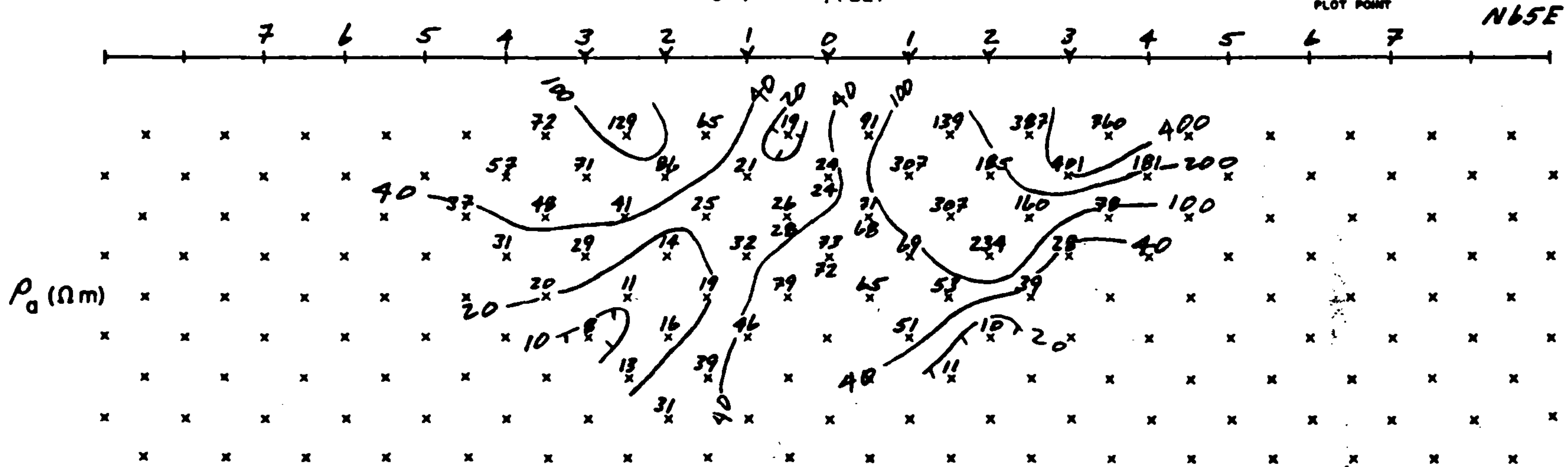
FIGURE G1
LINE LOCATION MAP
RESISTIVITY SURVEY
CHEMICAL DISPOSAL PIT
NUMBER 3
HILL AIR FORCE BASE, UTAH

EARTH SCIENCE LABORATORY
UNIVERSITY of UTAH RESEARCH INSTITUTE

DIPOLE - DIPOLE ARRAY
APPARENT RESISTIVITY



a = 30 FEET

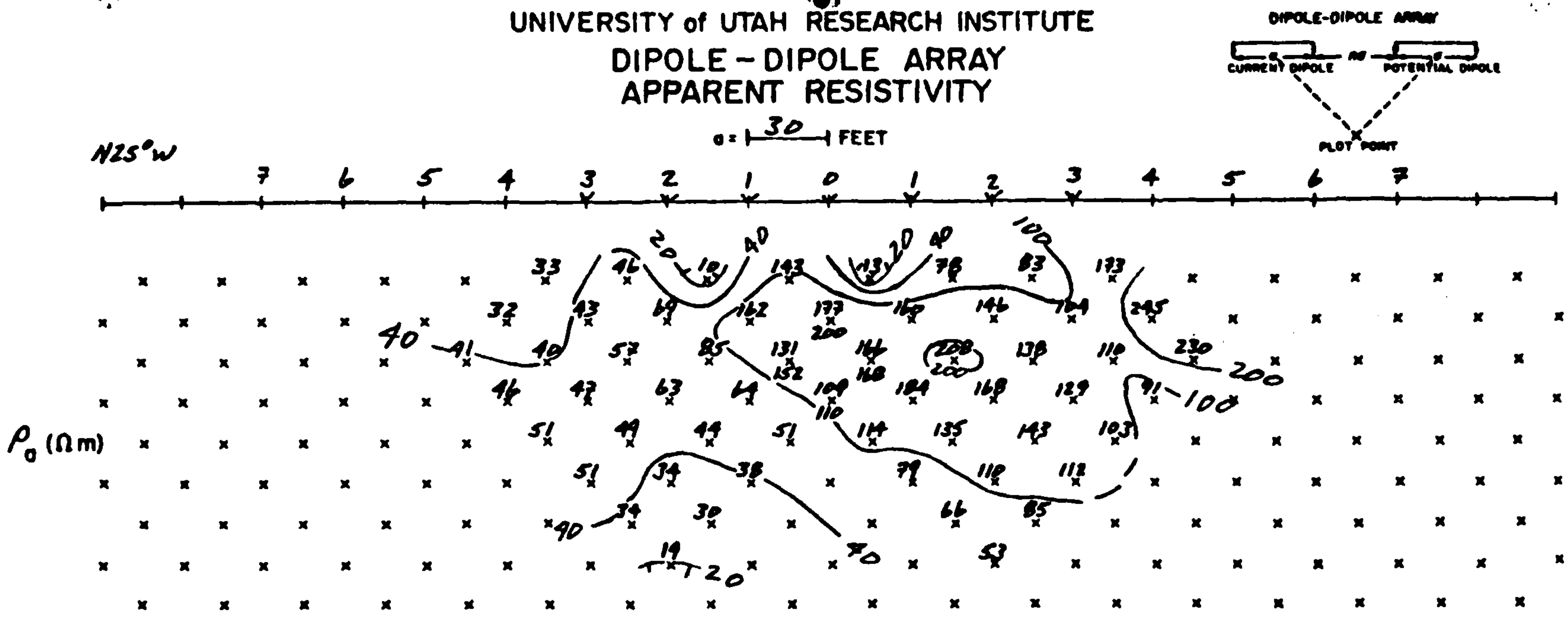


Note: Pit is between sta 0-1SW & sta 0-1NE sta 5-6NE straddle oiled road

AREA CHEMICAL PIT No. 3 STATE UTAH LINE 1 DATA BY C2M DATE 10/28/82 TRANSMITTER Phoenix RECEIVER Fluke
H.. AFB

FIGURE G2

EARTH SCIENCE LABORATORY
UNIVERSITY of UTAH RESEARCH INSTITUTE
DIPOLE - DIPOLE ARRAY
APPARENT RESISTIVITY



Note: Line is parallel to pits. sta 1SE also sta 1NE Line 1. Line is parallel to ungrounded Power line.

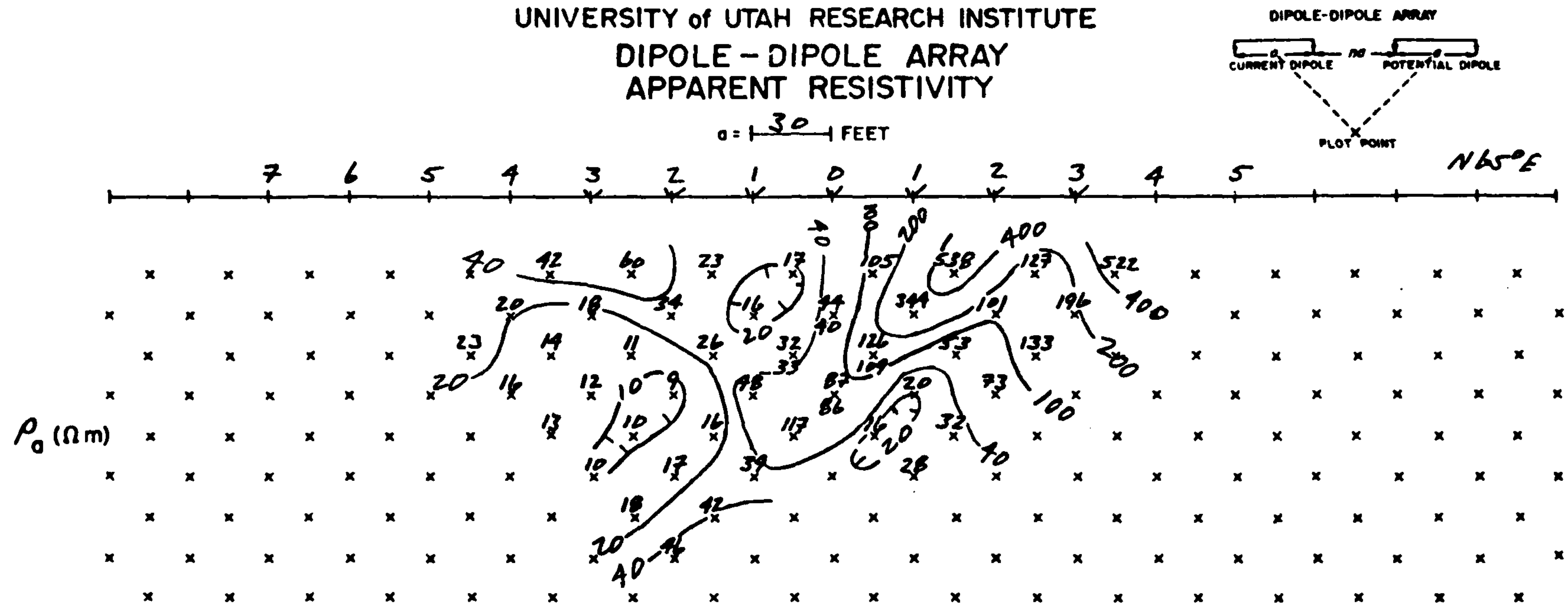
AREA CHEMICAL PIT No. 3 STATE UTAH LINE 2 DATA BY CEM DATE 10/29/82 TRANSMITTER Phoenix RECEIVER Fluke
HILL AFB

FIGURE G3

EARTH SCIENCE LABORATORY
UNIVERSITY of UTAH RESEARCH INSTITUTE

DIPOLE - DIPOLE ARRAY APPARENT RESISTIVITY

a = 30 FEET

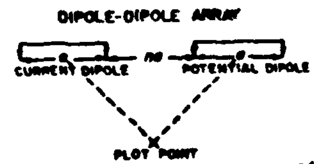


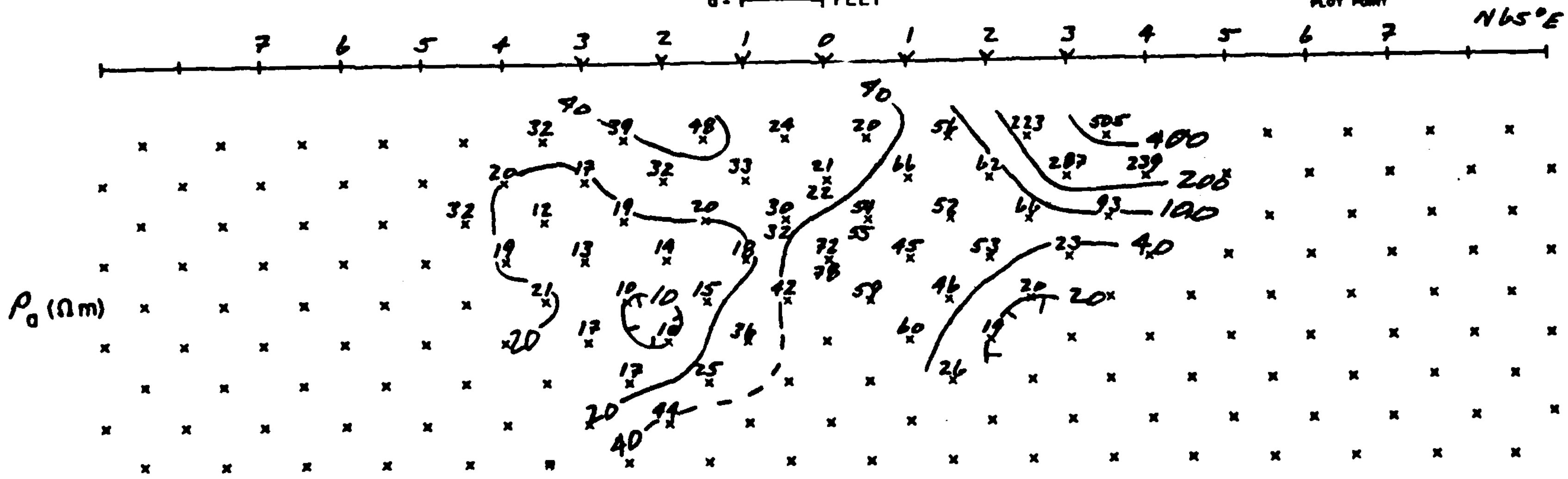
Note: oiled road between sta 4-5 NE
sta 0 also sta 2NW Line 2

AREA CHEMICAL PITS No. 3 STATE UTAH LINE 3 DATA BY CEM DATE 11/16/82 TRANSMITTER Elliot RECEIVER Fluke
ILL AFB Time-Domain

FIGURE G4

EARTH SCIENCE LABORATORY
UNIVERSITY of UTAH RESEARCH INSTITUTE
DIPOLE - DIPOLE ARRAY
APPARENT RESISTIVITY





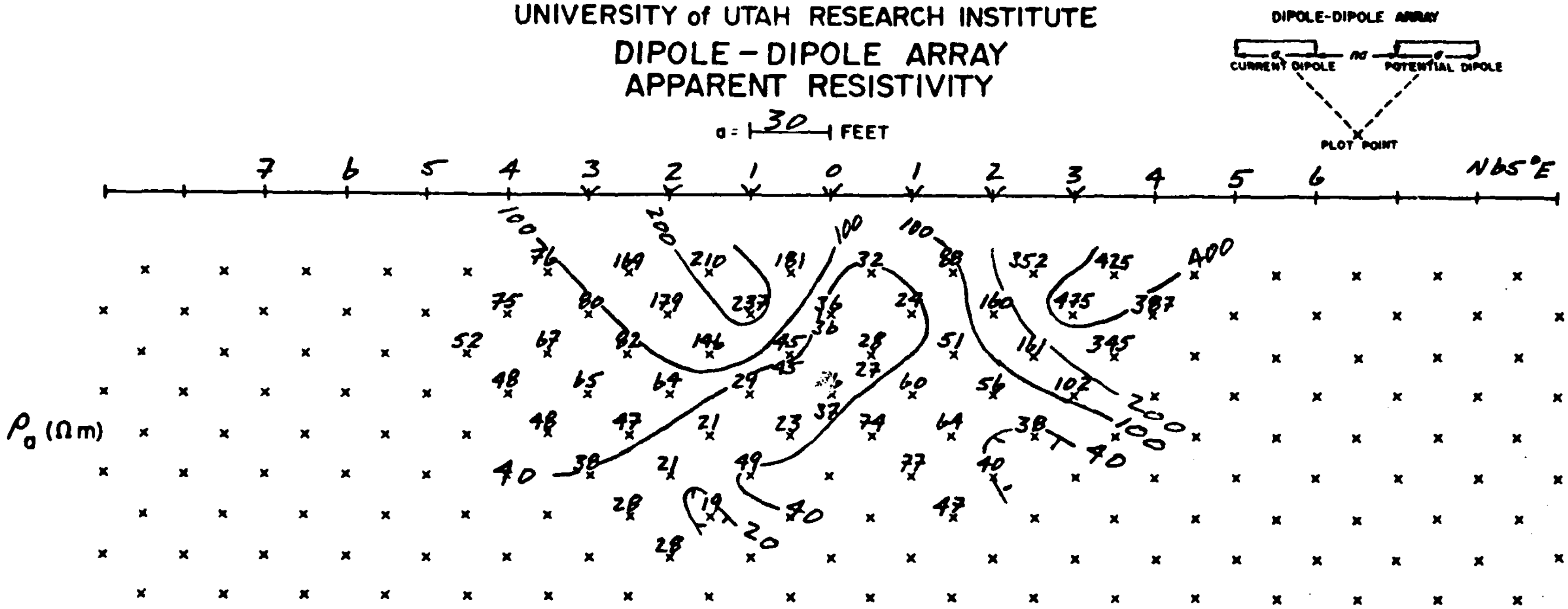
Note: sta 0 also sta 5NW Line 2 oiled road between sta 5-6NE

AREA CHEMICAL PIT No. 3 HILL AFB STATE UTAH LINE 4 DATA BY C2M DATE 11/17/82 TRANSMITTER Elliot RECEIVER Fluke Time-Domain

FIGURE G5

EARTH SCIENCE LABORATORY
UNIVERSITY of UTAH RESEARCH INSTITUTE
DIPOLE - DIPOLE ARRAY
APPARENT RESISTIVITY

a = 30 FEET

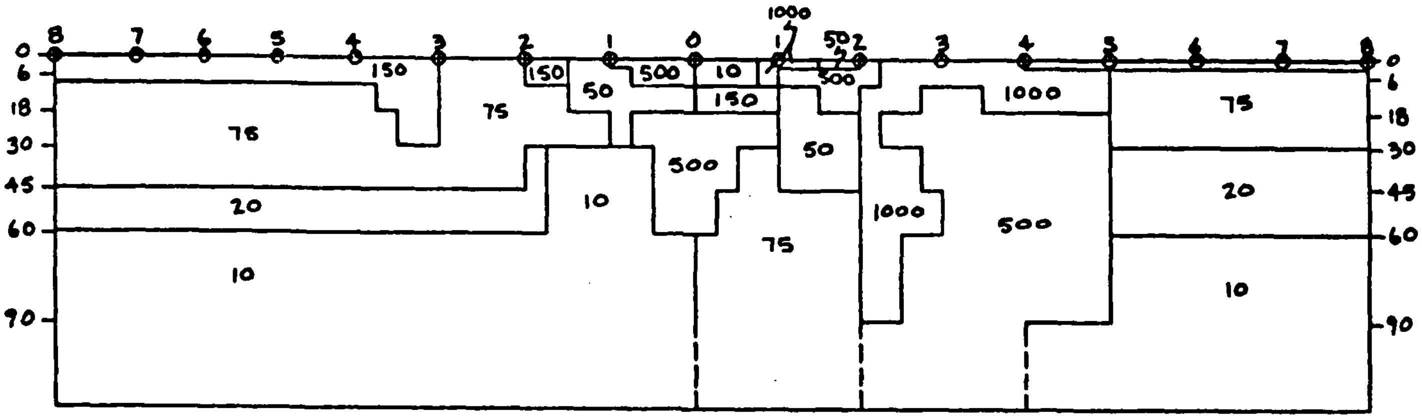


Note: sta 2NE also sta 4SE Line 2
oiled road between stations
5-6NE

AREA CHEMICAL PIT No. 3 STATE UTAH LINE 5 DATA BY CEM DATE 11/22/82 TRANSMITTER BISON RECEIVER BISON

HILL AFB

FIGURE G6



APPARENT RESISTIVITY - COMPUTED

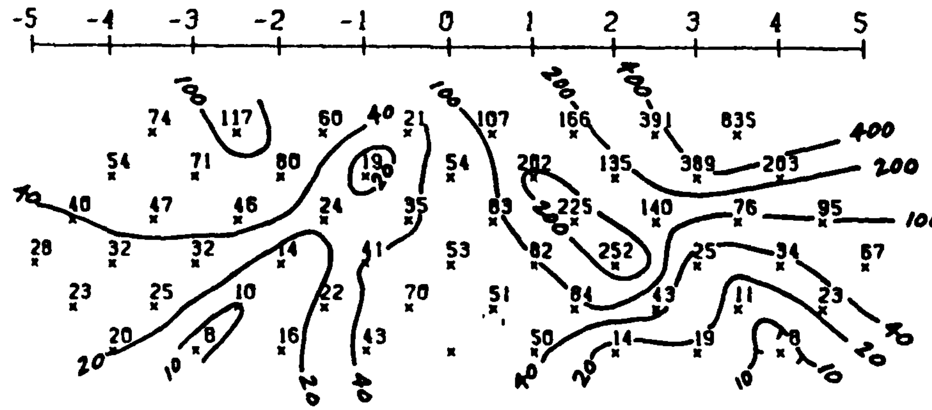


Figure G7 Computed Model
Line 1, Chemical Disposal
Pit No. 3
Hill Air Force Base, Utah

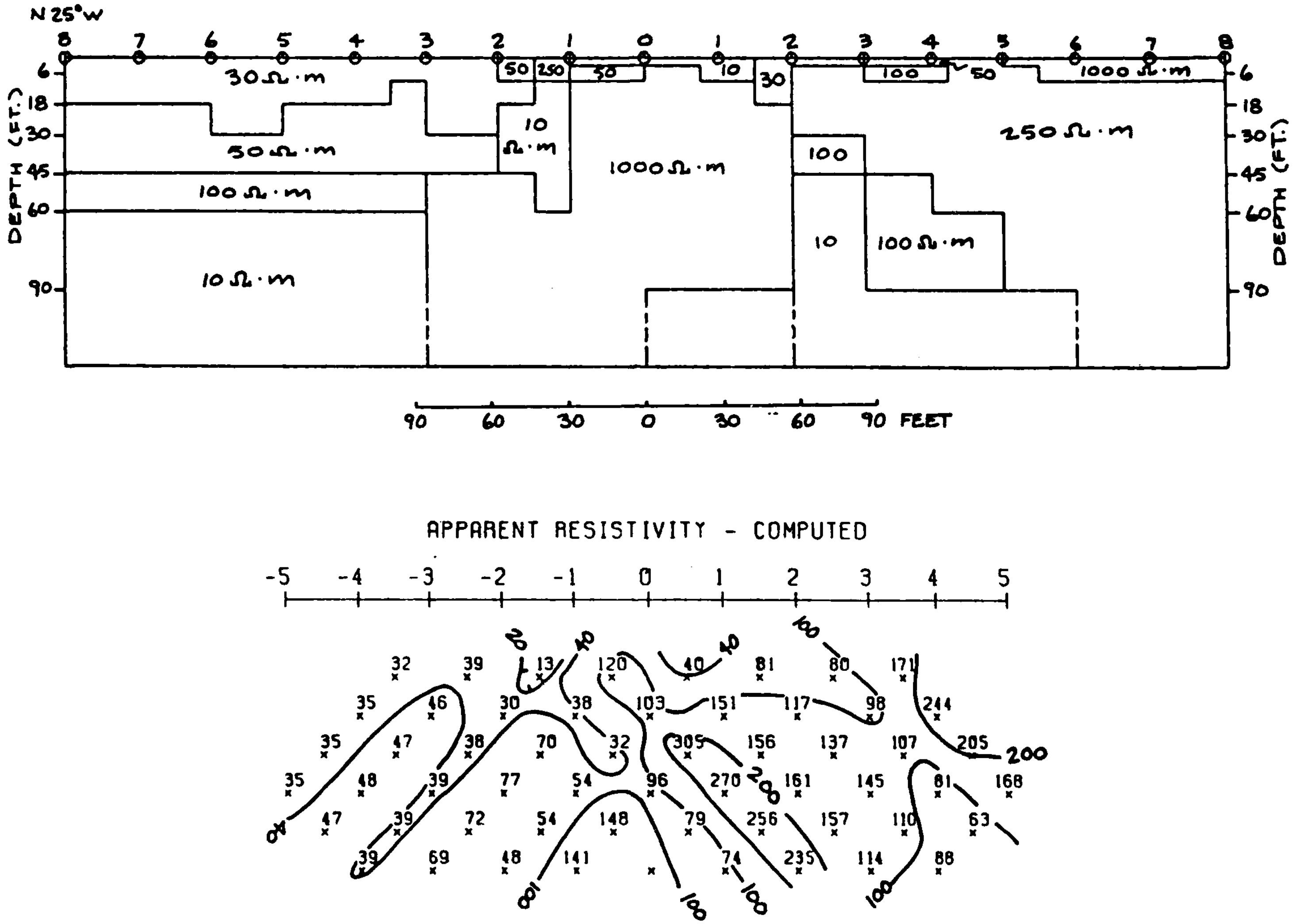


Figure G8 Computed Model
Line 2, Chemical Disposal
Pit No. 3
Hill Air Force Base, Utah

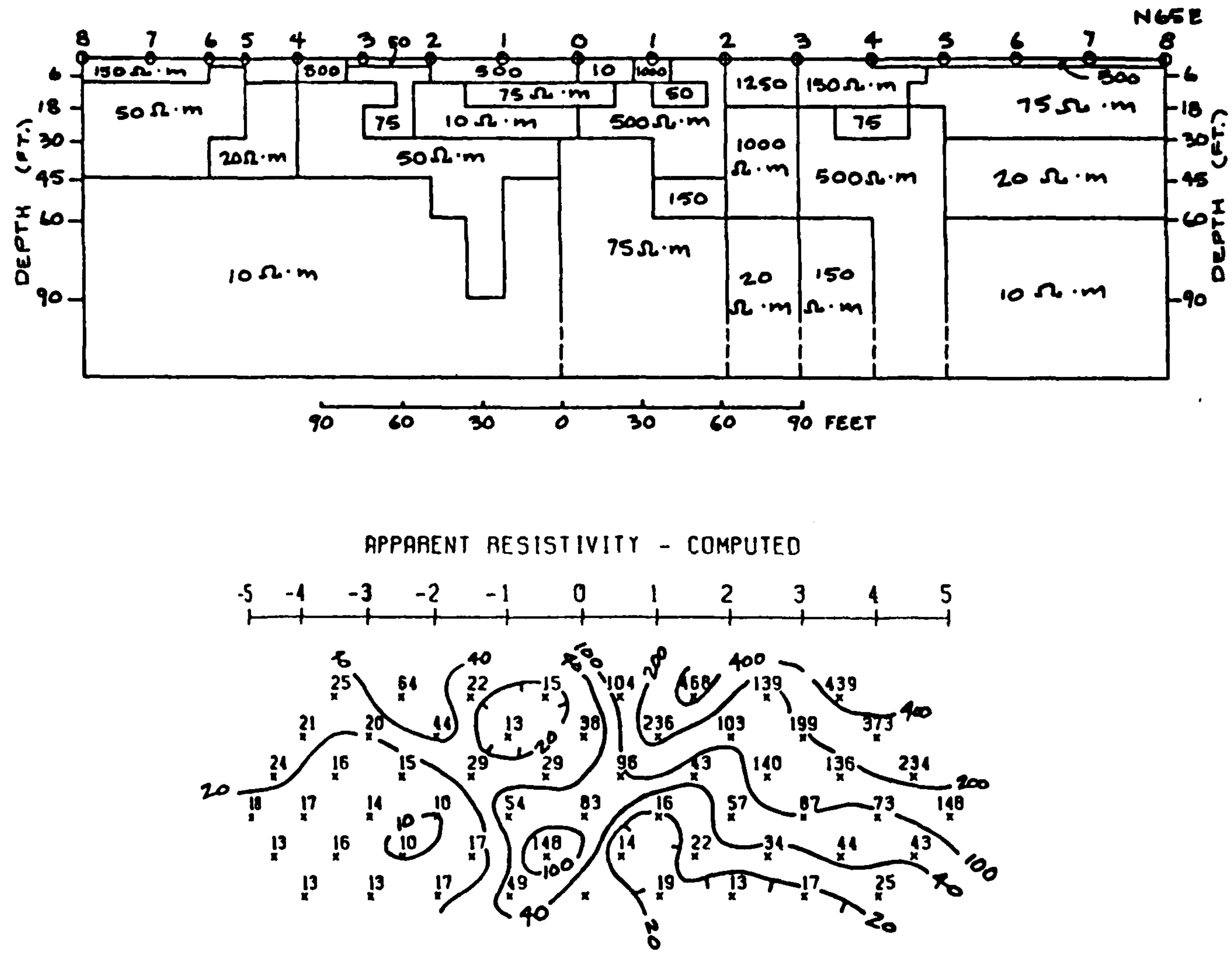


Figure G9 Computed Model
Line 3, Chemical Disposal
Pit No. 3
Hill Air Force Base, Utah

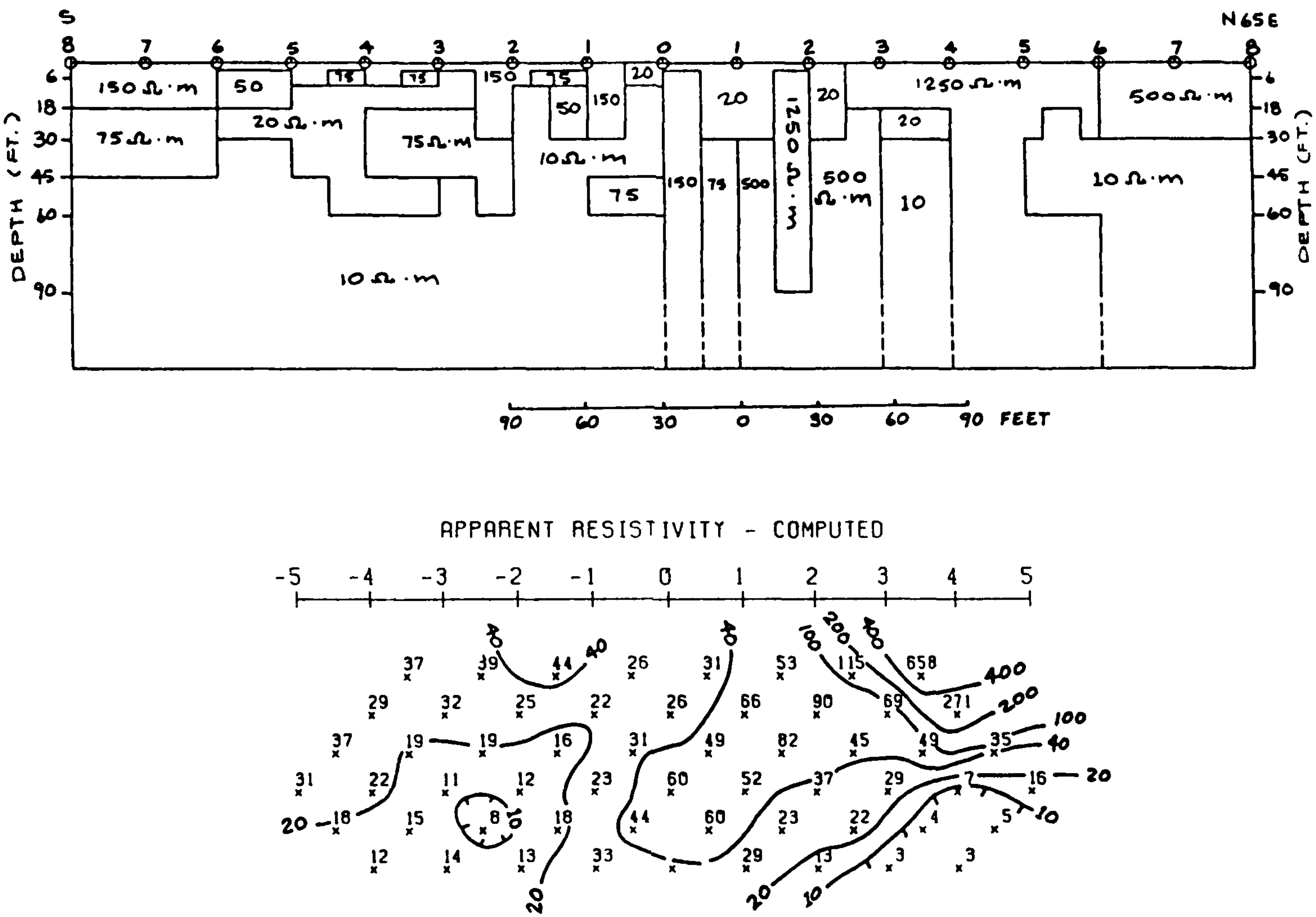


Figure G10 Computed Model
Line 4, Chemical Disposal
Pit No. 4
Hill Air Force Base, Utah

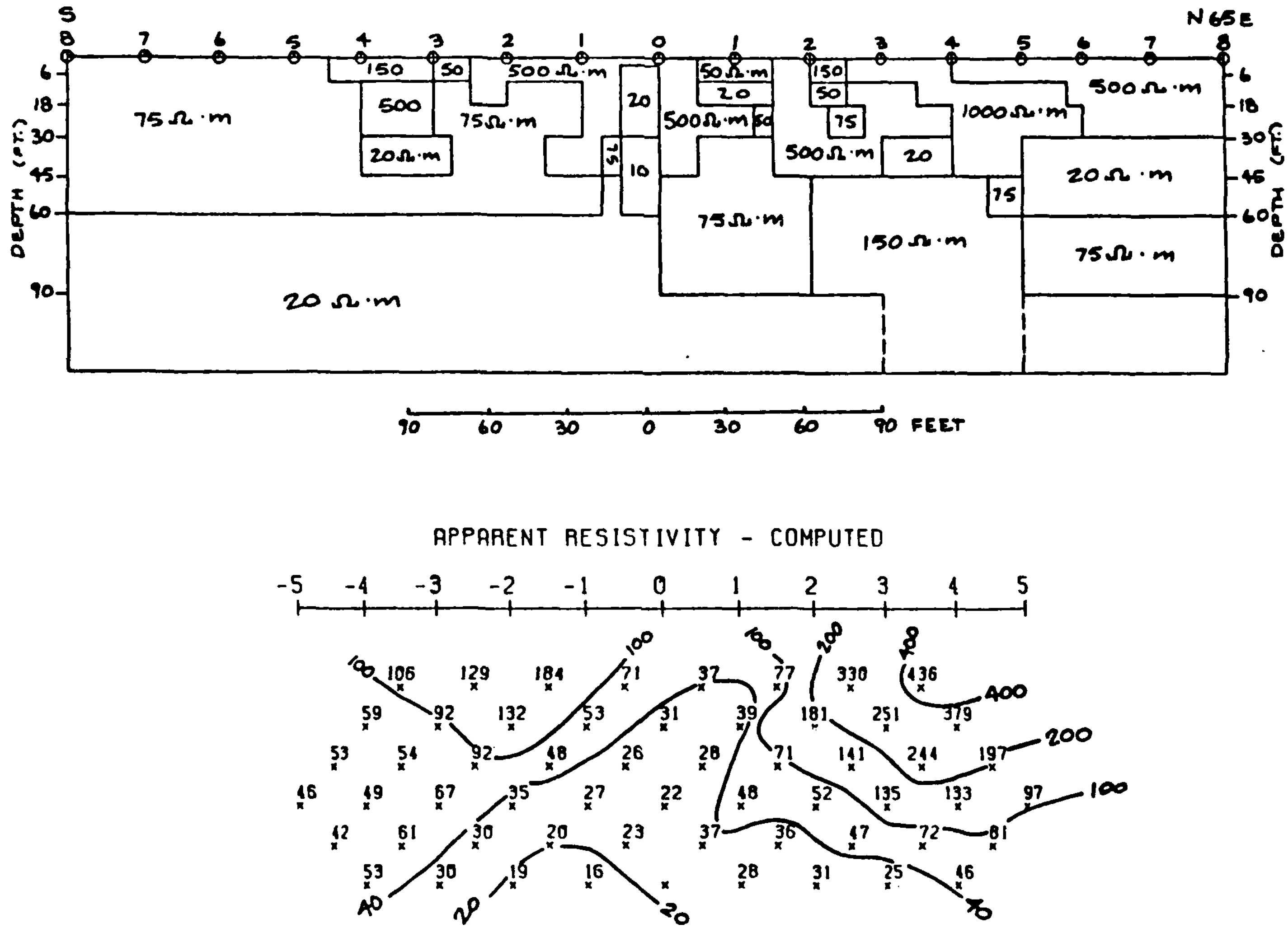


Figure G11 Computed Model
Line 5, Chemical Disposal
Pit No. 3
Hill Air Force Base, Utah

CHEMICAL DISPOSAL PIT #3

Structural Interpretation

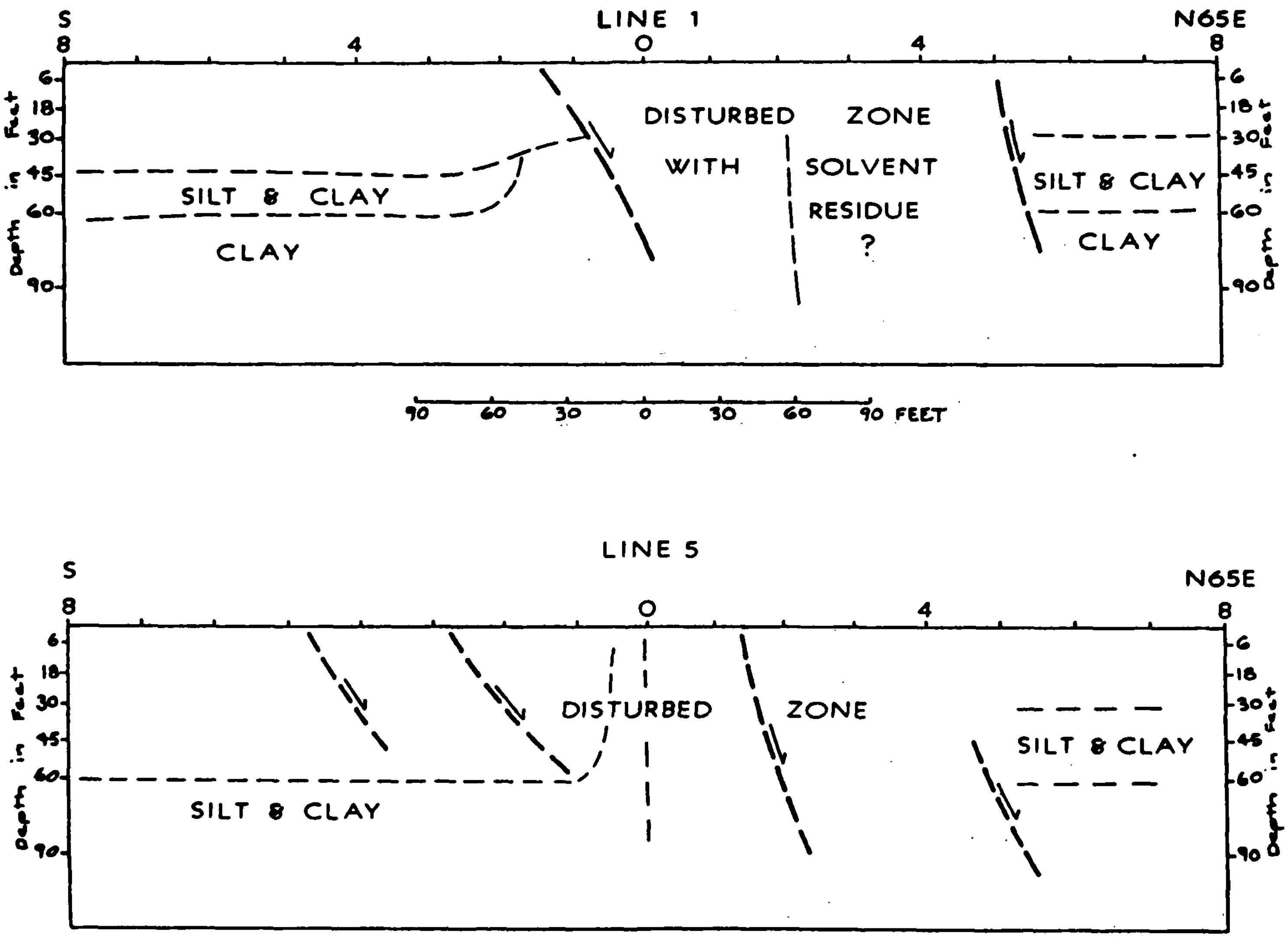


Figure G12

CHEMICAL DISPOSAL PIT #3

Structural Interpretation

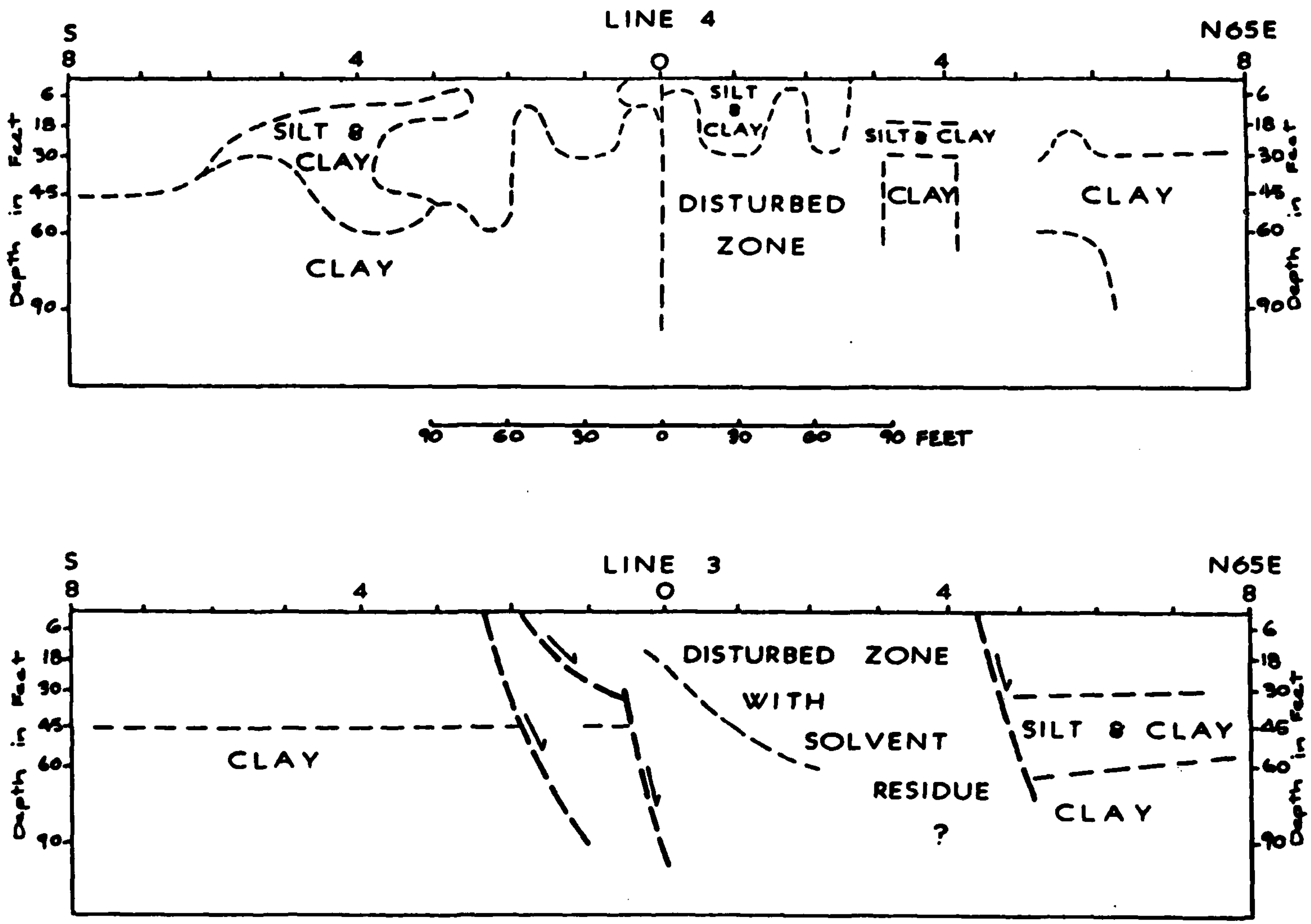


Figure G 13

CHEMICAL DISPOSAL PIT #3

Structural Interpretation

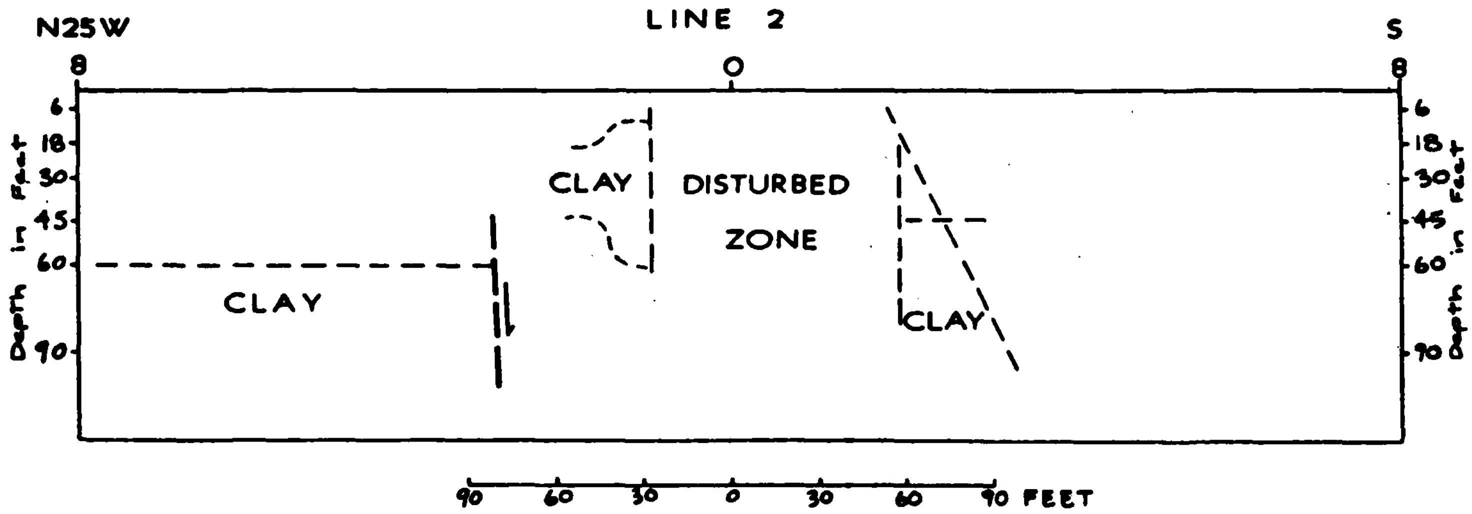


Figure G14

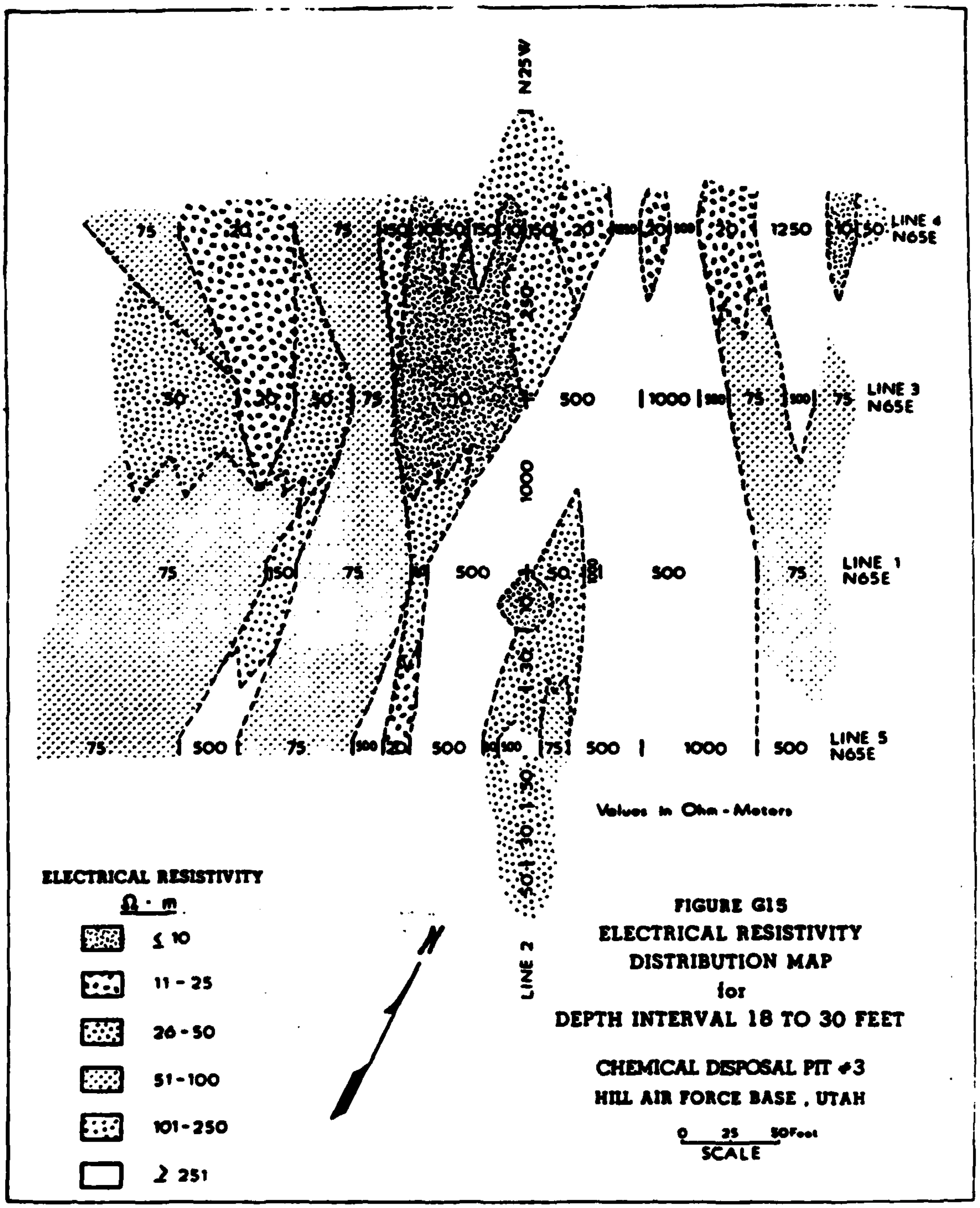


FIGURE G15
ELECTRICAL RESISTIVITY
DISTRIBUTION MAP
for
DEPTH INTERVAL 18 TO 30 FEET

CHEMICAL DISPOSAL PIT #3
HILL AIR FORCE BASE, UTAH

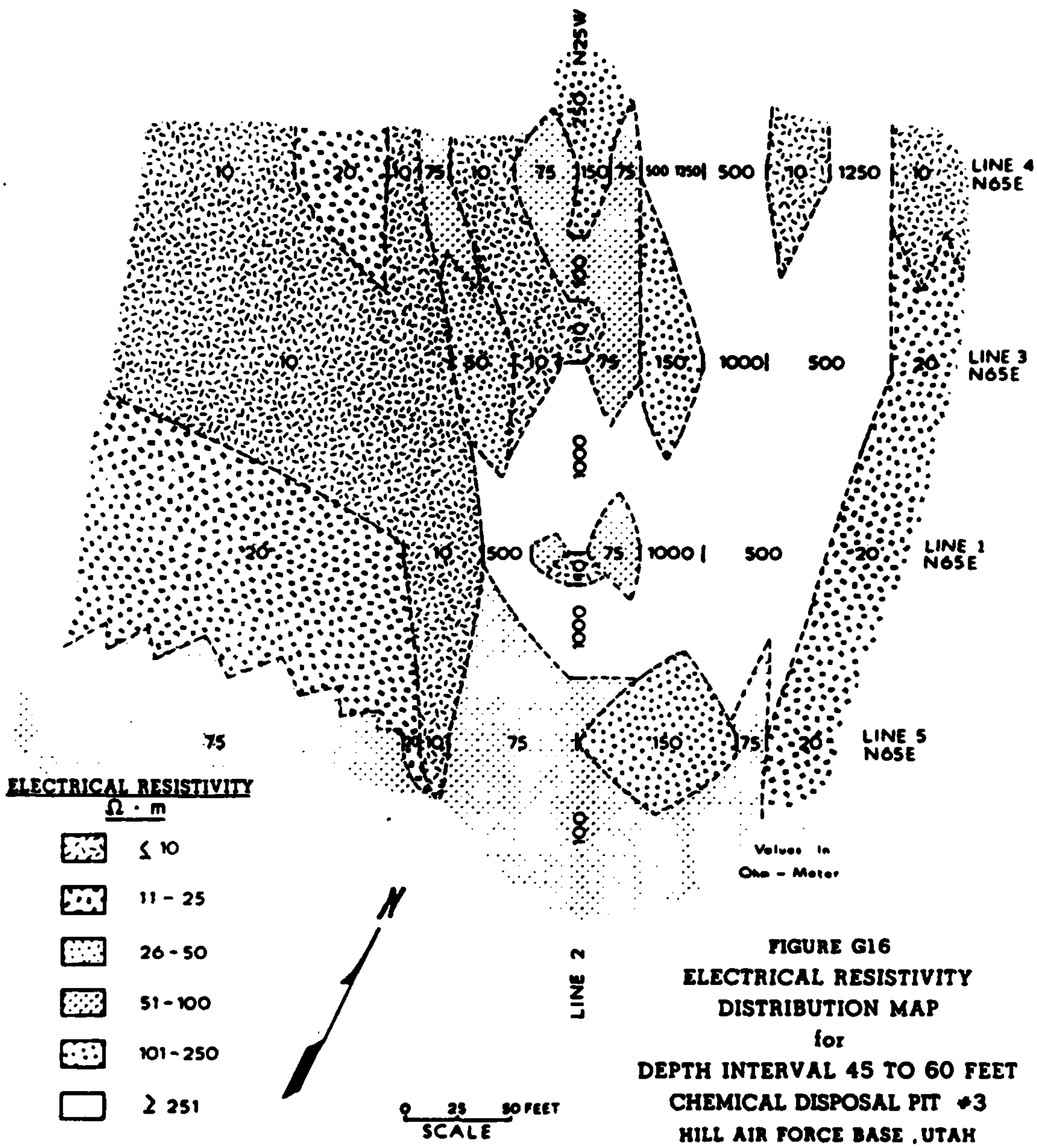


FIGURE G16
ELECTRICAL RESISTIVITY DISTRIBUTION MAP
for
DEPTH INTERVAL 45 TO 60 FEET
CHEMICAL DISPOSAL PIT #3
HILL AIR FORCE BASE, UTAH

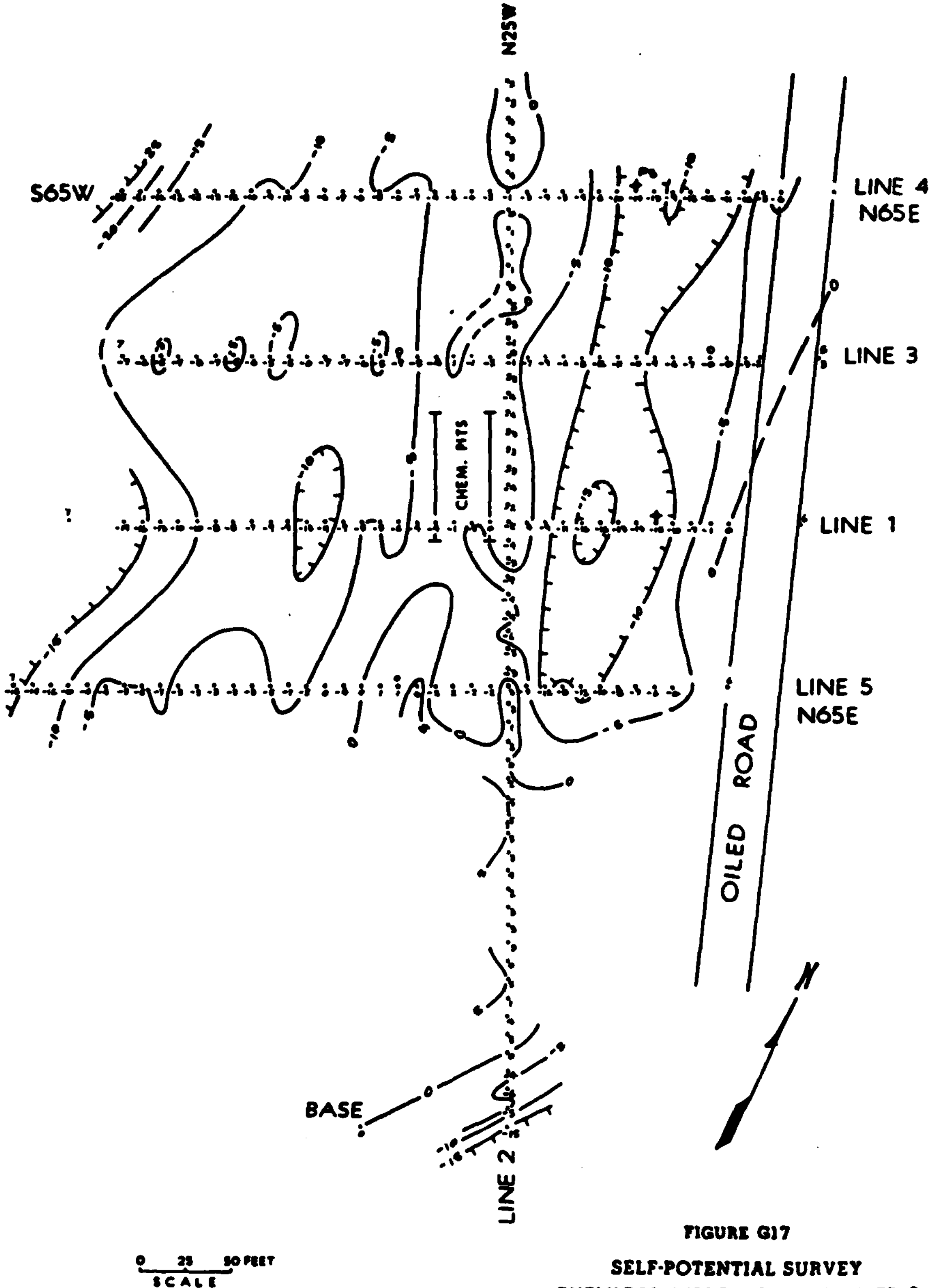


FIGURE G17
SELF-POTENTIAL SURVEY
CHEMICAL DISPOSAL PIT NUMBER 3
HILL AIR FORCE BASE, UTAH
CI = 5mV

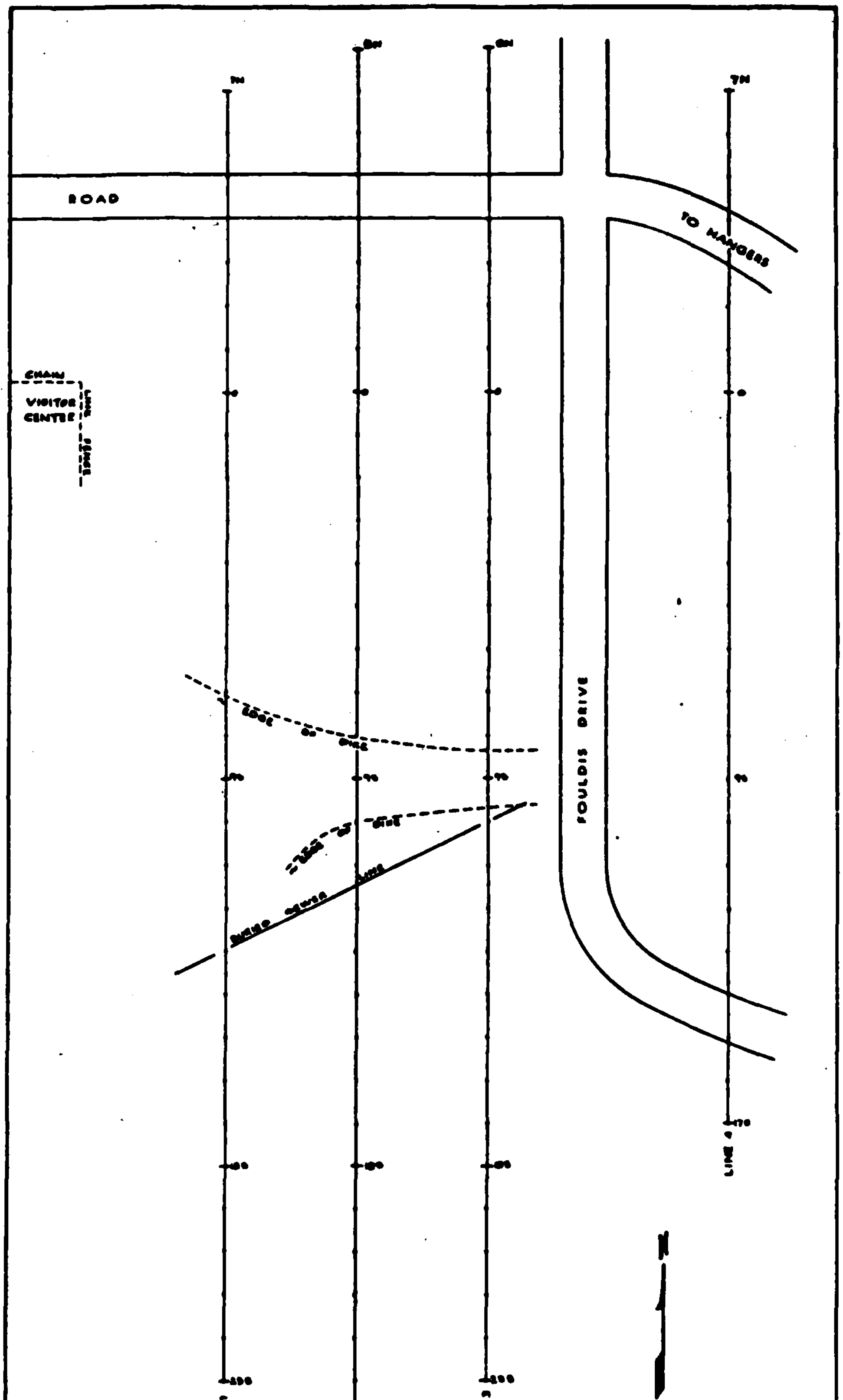
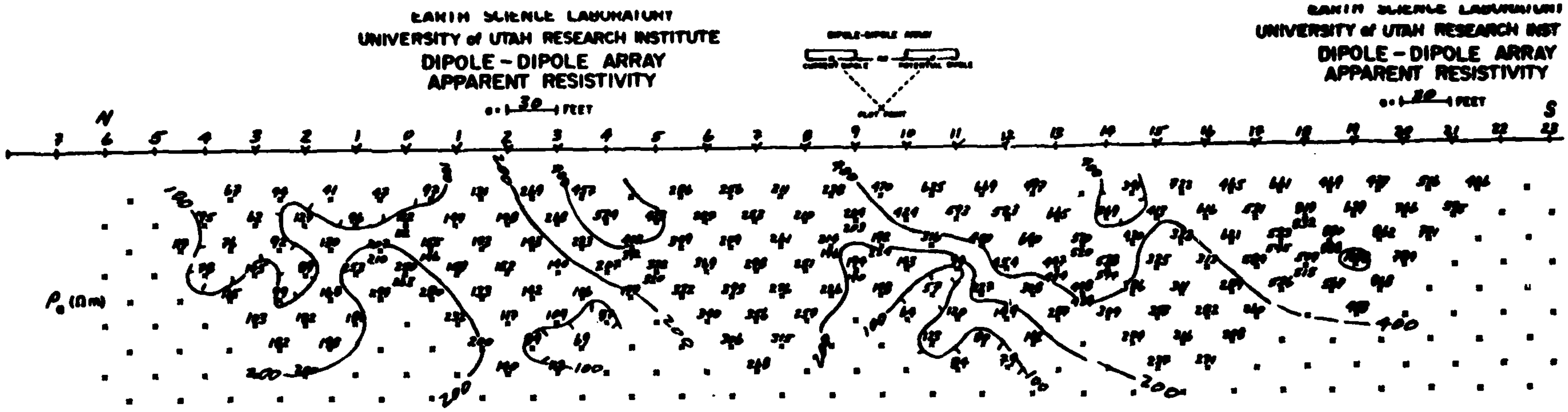


FIGURE G18
LINE LOCATION MAP
ELECTRICAL RESISTIVITY SURVEY
BERMAN POND AREA

HILL AIR FORCE BASE, UTAH

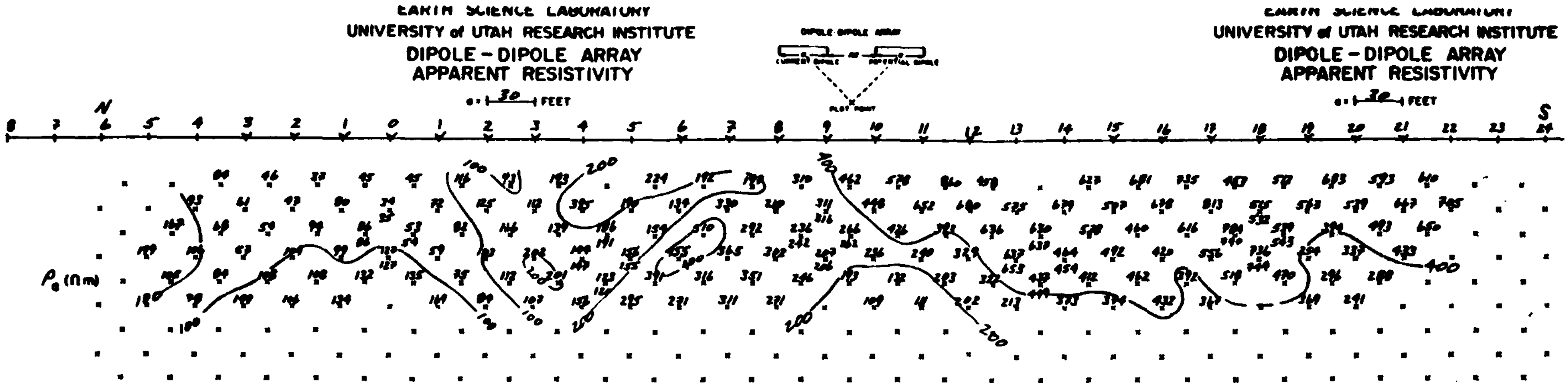
Scale 1"=50'



Note: oiled road between sta 4-5N
Buried sewer line beneath sta 13S
old dike between sta 12-13S.
chain link fence 90'W and 30'S
of Line

AREA BERMAN POND HILL AFB STATE UTAH LINE 1 DATA BY CEM DATE 11/23/82 TRANSMITTER ELLIOT RECEIVER Fluke

FIGURE G19



Note: oiled road between sta 4-5N
old dike between sta 8-10S

AREA BERMAN POND HILL AFB STATE UTAH LINE 2 DATA BY CEM DATE 11/23/82 TRANSMITTER BISON RECEIVER BISON STATE LINE DATA BY DATE

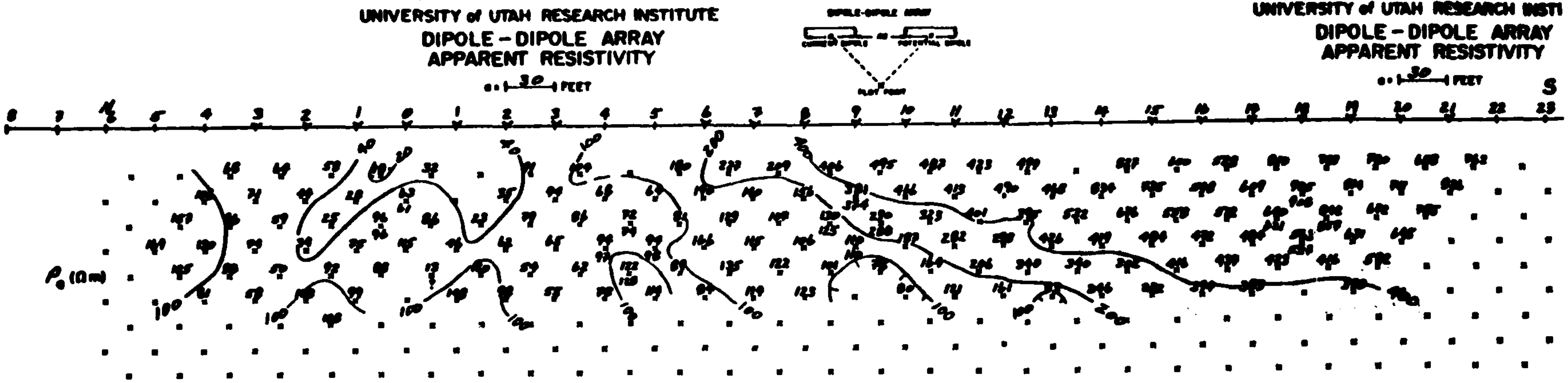
FIGURE G20

EARTH SCIENCE LABORATORY
UNIVERSITY of UTAH RESEARCH INSTITUTE
DIPOLE - DIPOLE ARRAY
APPARENT RESISTIVITY

a = 30 FEET

EARTH SCIENCE LABORATORY
UNIVERSITY of UTAH RESEARCH INSTI
DIPOLE - DIPOLE ARRAY
APPARENT RESISTIVITY

a = 30 FEET



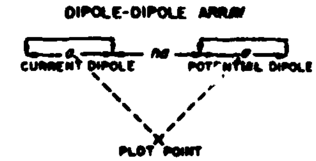
Note: oiled road between sta 4-5N

AREA BERMAN POND STATE UTAH LINE 3 DATA BY CEM DATE 12/16/82 TRANSMITTER BISON RECEIVER BISON STATE LINE DATA BY DAY

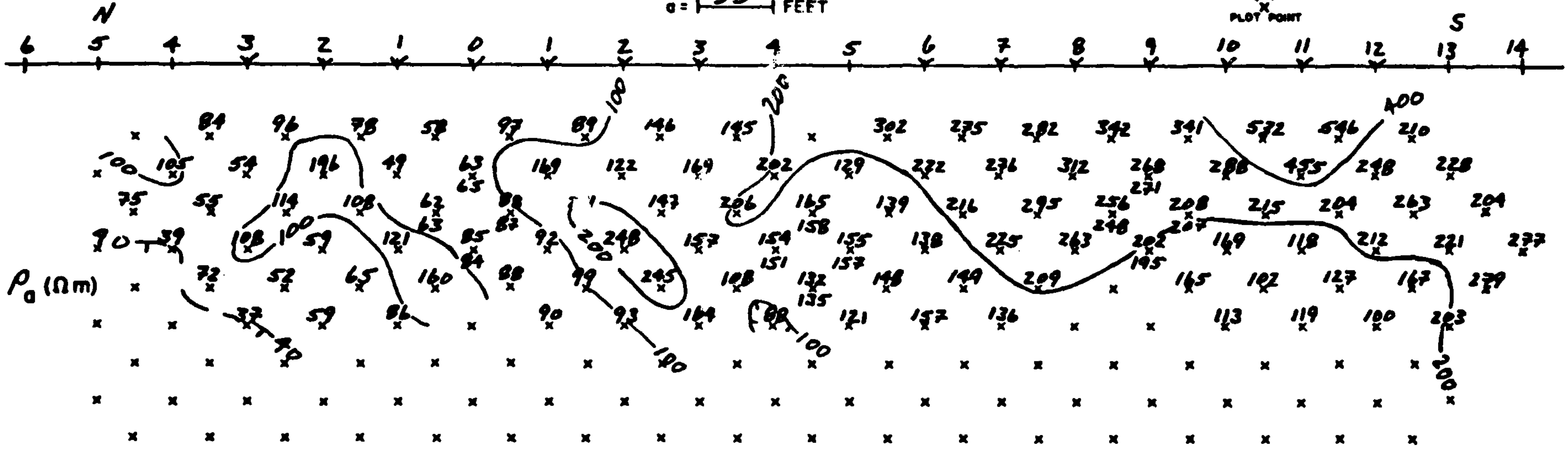
FIGURE G21

EARTH SCIENCE LABORATORY
UNIVERSITY of UTAH RESEARCH INSTITUTE

DIPOLE – DIPOLE ARRAY
APPARENT RESISTIVITY



a = 30 FEET



Note: sta 3N is 10'So. of oiled road
Line is 85'E of Fouldis Drive

AREA BERMAN POND STATE UTAH LINE 4 DATA BY CEM DATE 12/10/82 TRANSMITTER BISON RECEIVER BISON
H L AFB

FIGURE G22

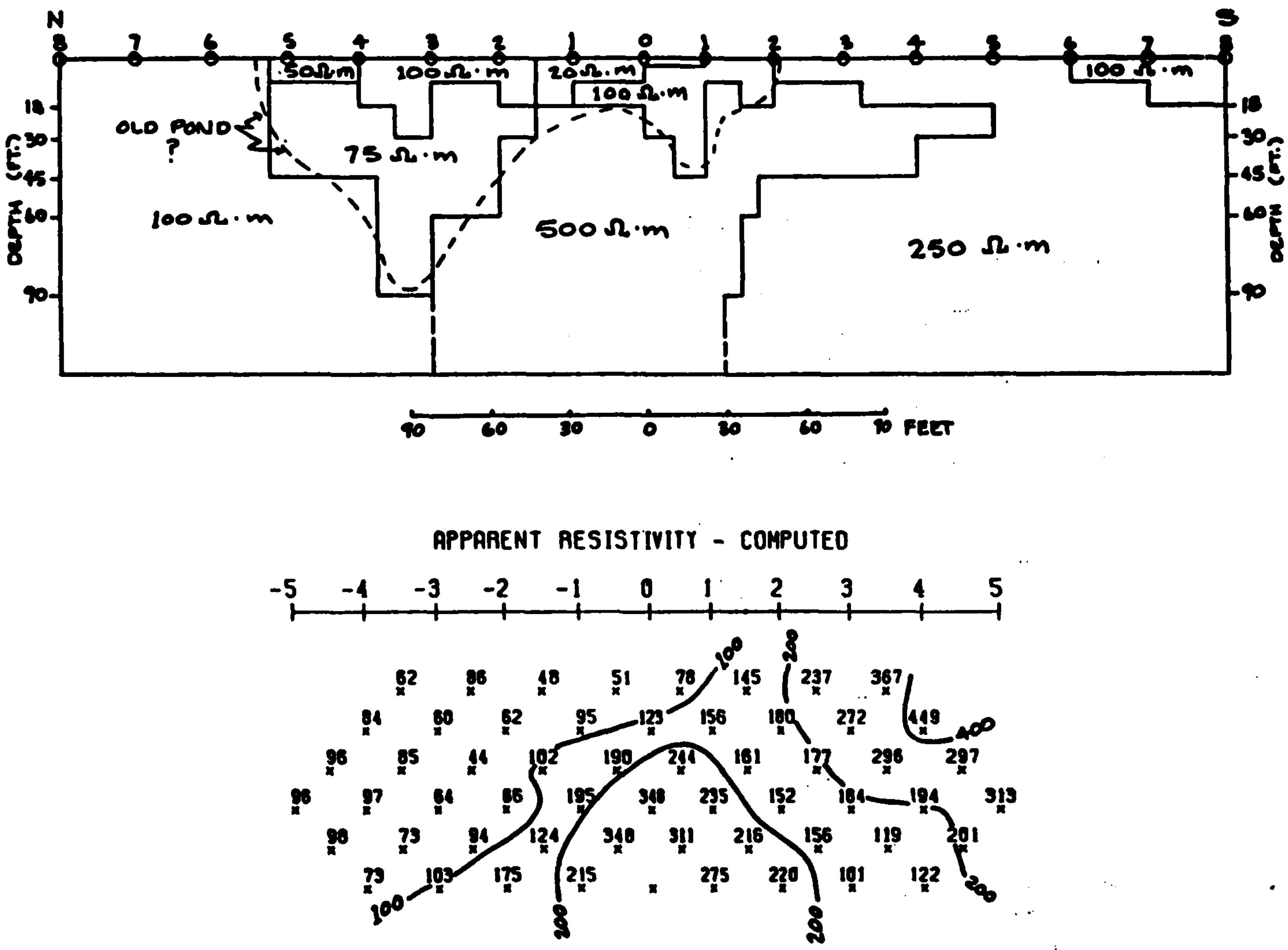


Figure G23 Computed Model
Line 1, Berman Pond
Hill Air Force Base, Utah

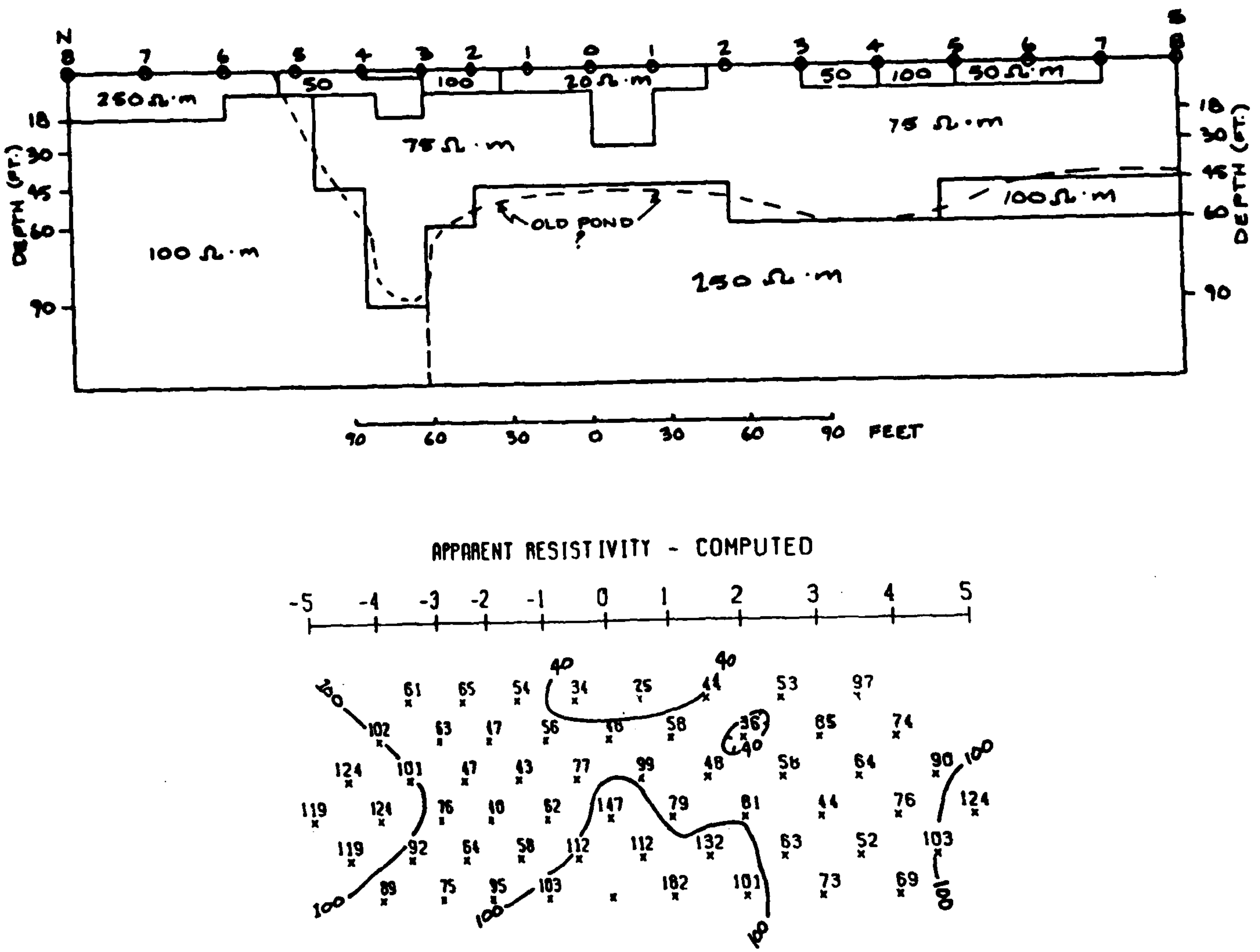


Figure G24 Computed Model
Line 3, Berman Pond
Hill Air Force Base, Utah

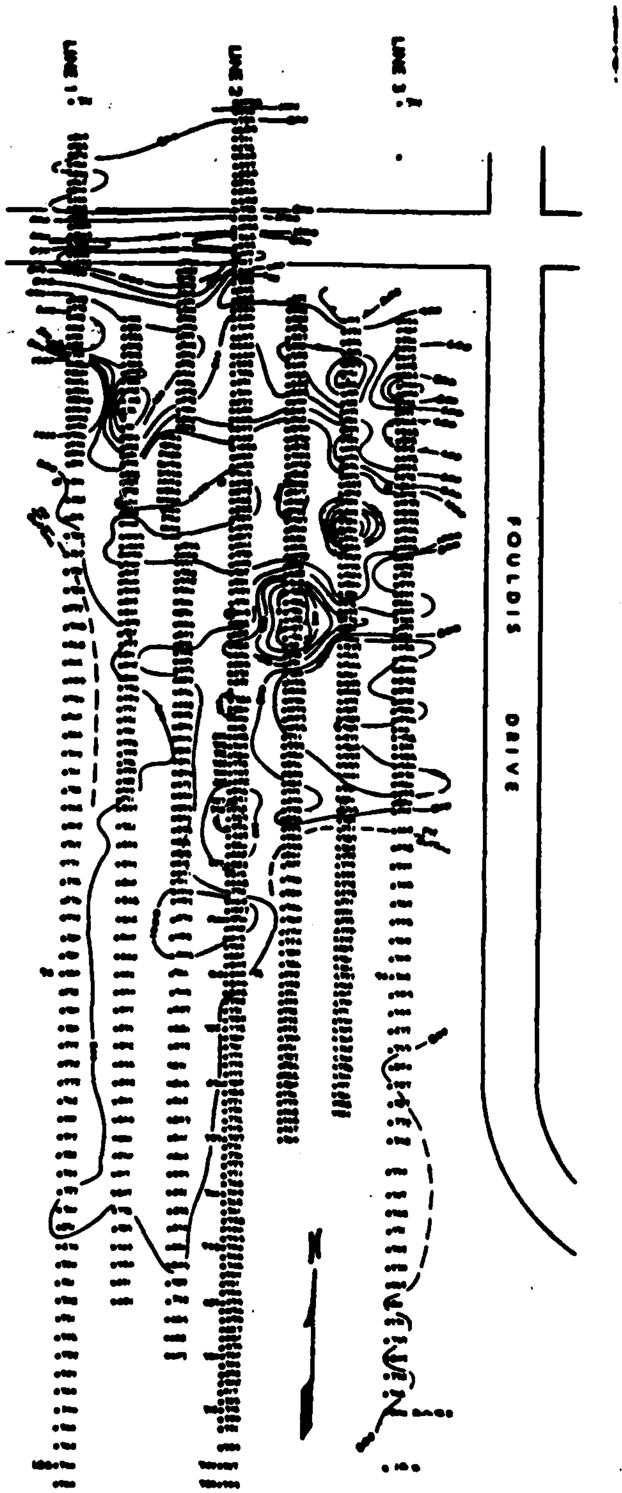
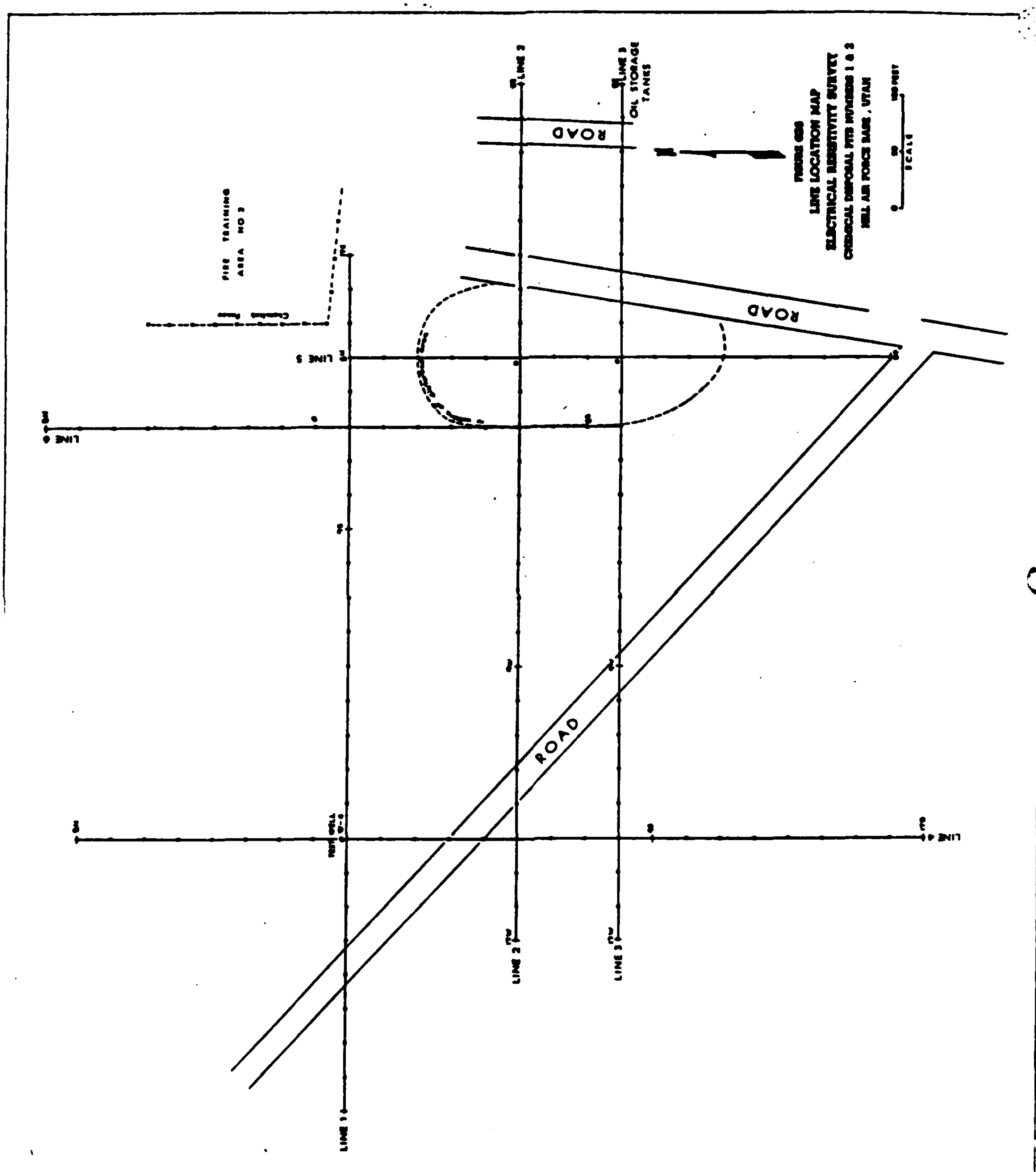


FIGURE G25
BERMAN POND AREA
GROUND MAGNETIC SURVEY
HILL AIR FORCE BASE, UTAH

Contour Interval - 200 gamma
0 25 50 feet
SCALE

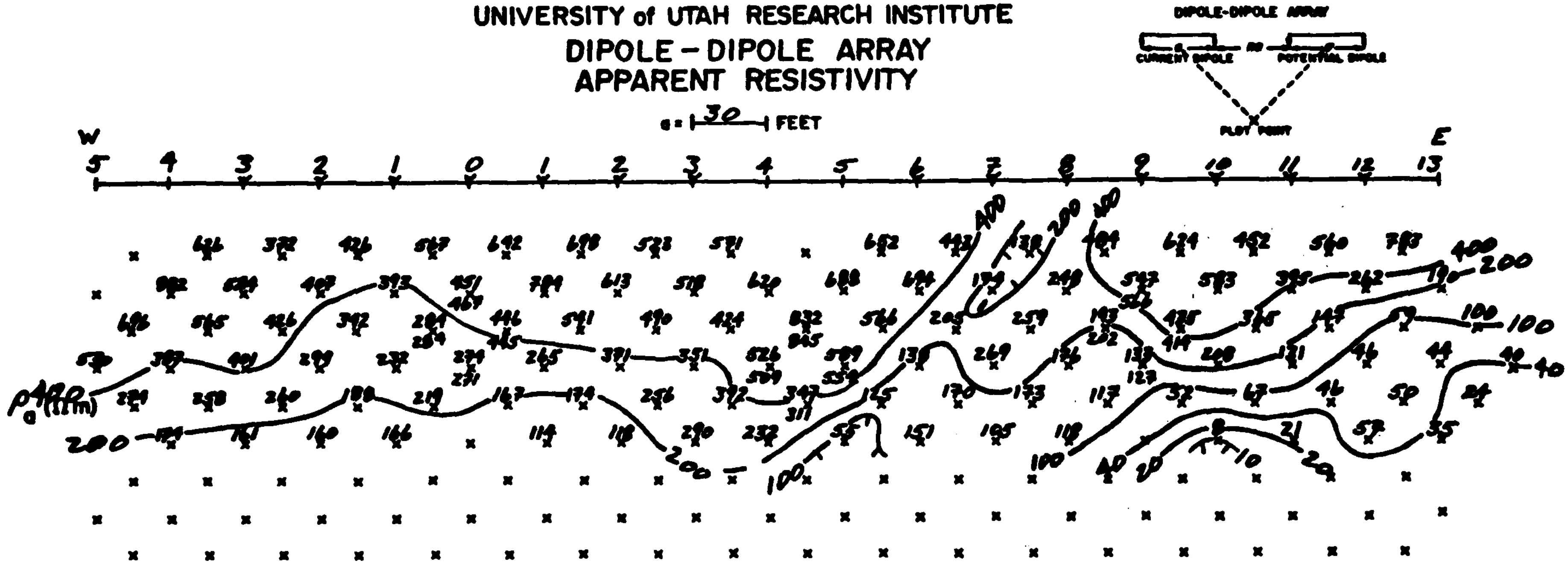


LINE LOCATION MAP
ELECTRICAL RESISTIVITY SURVEY
CHEMICAL DISPOSAL PITS NUMBERS 1 & 2
HILL AIR FORCE BASE, UTAH
SCALE
100 FEET
LINE 1
LINE 2
LINE 3
LINE 4
LINE 5
LINE 6
ROAD
ROAD
ROAD
OIL STORAGE TANKS
FIRE TRAINING AREA NO 2
TEST WELL

EARTH SCIENCE LABORATORY
UNIVERSITY of UTAH RESEARCH INSTITUTE

DIPOLE - DIPOLE ARRAY
APPARENT RESISTIVITY

a = 30 FEET

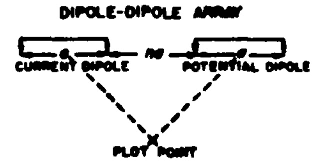


Note: sta 0 @ Test Well W-4

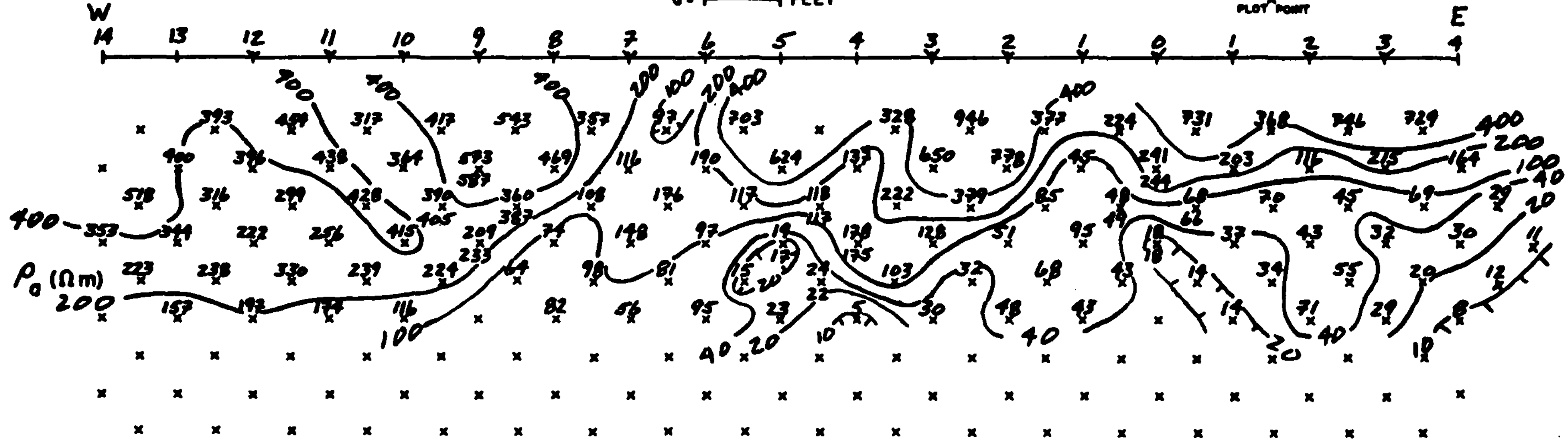
AREA CHEMICAL PITS 1 and 2 STATE UTAH LINE 1 DATA BY CEM DATE 12/16/82 TRANSMITTER BISON RECEIVER BISON
HILL AFB

FIGURE G27

EARTH SCIENCE LABORATORY
UNIVERSITY of UTAH RESEARCH INSTITUTE
DIPOLE - DIPOLE ARRAY
APPARENT RESISTIVITY



a = 30 FEET

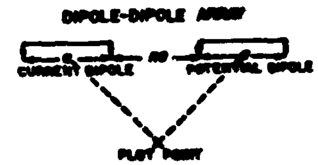


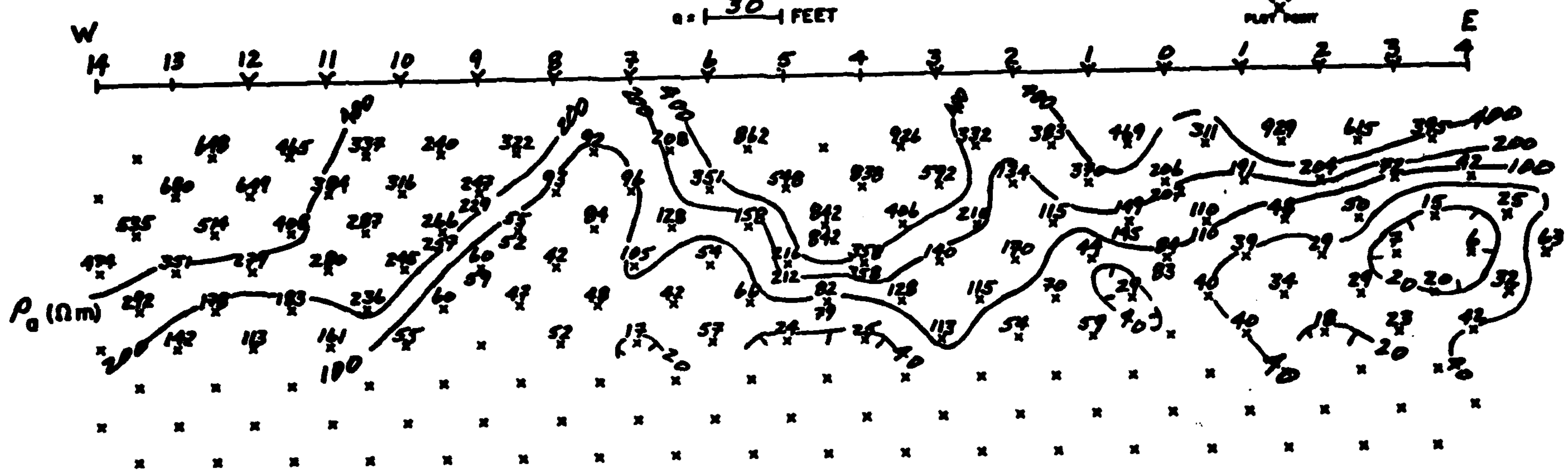
Note: sta 0 in center of Chemical Pit 2 Line centered 150'S, 180'E of sta 8E Line 1

AREA CHEMICAL PITS 1 and 2 HILL AFB STATE UTAH LINE 2 DATA BY CEM DATE 12/6/82 TRANSMITTER BISON RECEIVER BISON

FIGURE G28

EARTH SCIENCE LABORATORY
UNIVERSITY of UTAH RESEARCH INSTITUTE
DIPOLE – DIPOLE ARRAY
APPARENT RESISTIVITY





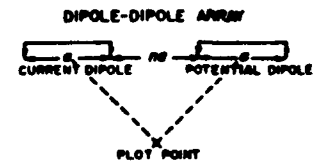
Note: sta 0 centered in Chemical Pit 1 sta 4-6E located just North of 3 Oil Storage tanks

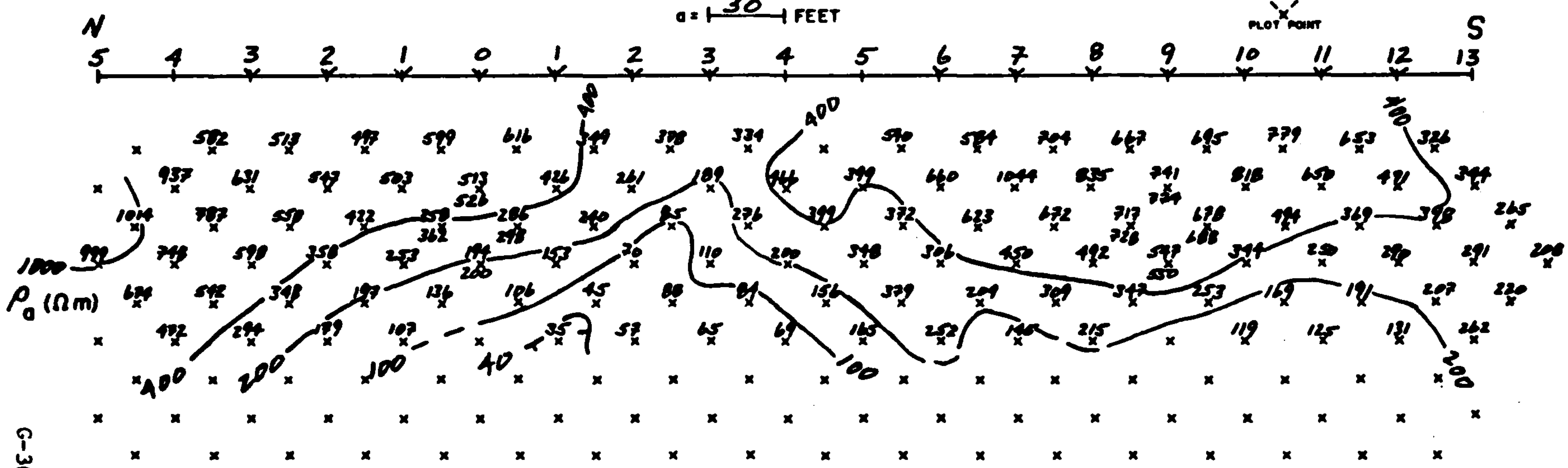
AREA CHEMICAL PITS 1 and 2 HILL AFB STATE UTAH LINE 3 DATA BY CEM DATE 12/6/82 TRANSMITTER BISON RECEIVER BISON

FIGURE G29

EARTH SCIENCE LABORATORY
UNIVERSITY of UTAH RESEARCH INSTITUTE

DIPOLE – DIPOLE ARRAY
APPARENT RESISTIVITY





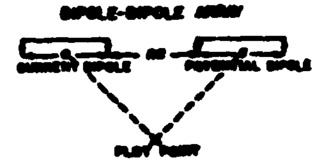
Note: sta 0 @ Test Well W-4

AREA CHEMICAL PITS 1 and 2 STATE UTAH LINE 4 DATA BY CEM DATE 12/10/82 TRANSMITTER BISON RECEIVER BISON

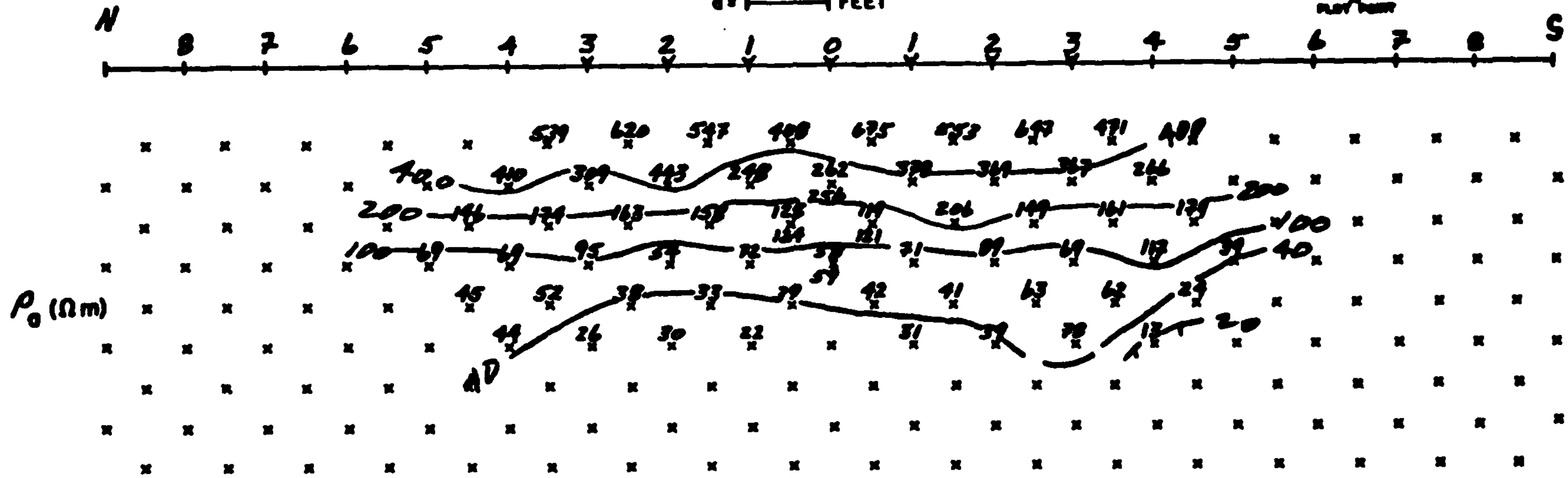
H AFB

FIGURE G30

EARTH SCIENCE LABORATORY
UNIVERSITY of UTAH RESEARCH INSTITUTE
DIPOLE - DIPOLE ARRAY
APPARENT RESISTIVITY



a = 30 FEET

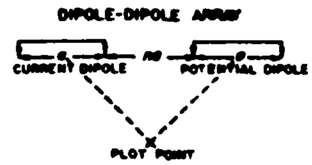


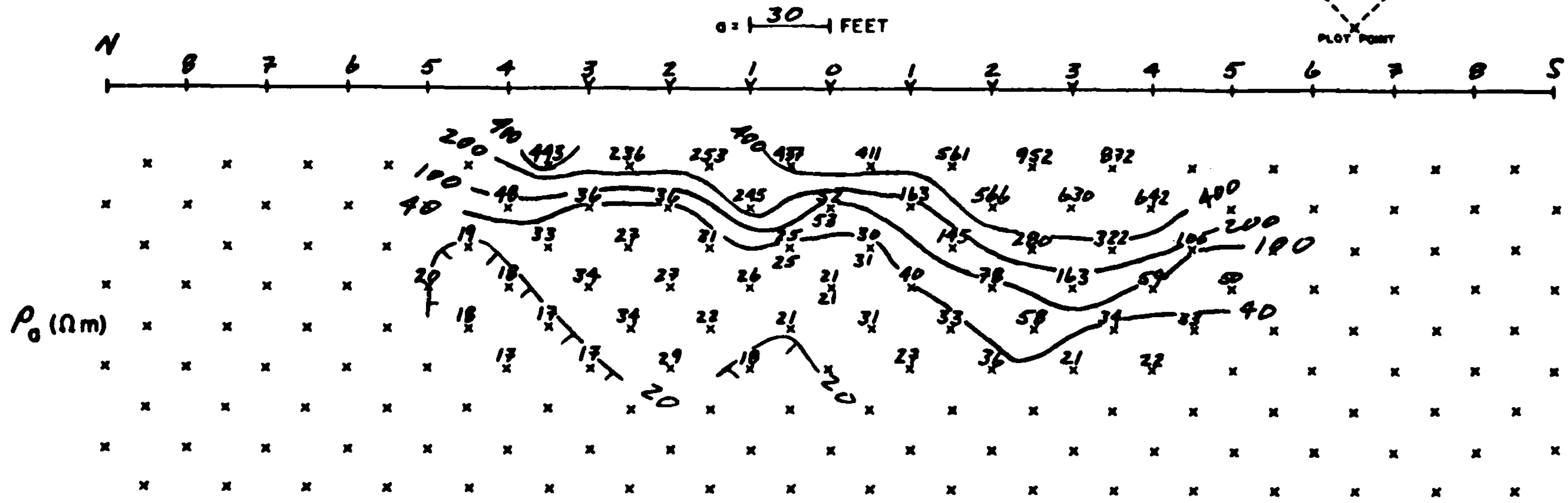
Note: sta 0 in center of Chemical Pit 1
sta 0 also sta 0 Line 3
sta 3N also sta 0 Line 2

AREA CHEMICAL PITS 1 and 2 STATE UTAH LINE 5 DATA BY CEM DATE 12/21/82 TRANSMITTER BISON RECEIVER BISON
HILL AFB

FIGURE G31

EARTH SCIENCE LABORATORY
UNIVERSITY of UTAH RESEARCH INSTITUTE
DIPOLE - DIPOLE ARRAY
APPARENT RESISTIVITY





G-32

Note: North half of Line in depression
sta 1S also sta 12E Line 1
sta 6S ~20°N of sta 2W Line 2

AREA CHEMICAL PITS 1 and 2 STATE UTAH LINE 6 DATA BY CEM DATE 12/21/82 TRANSMITTER BISON RECEIVER BISON
HILL AFB

FIGURE G32

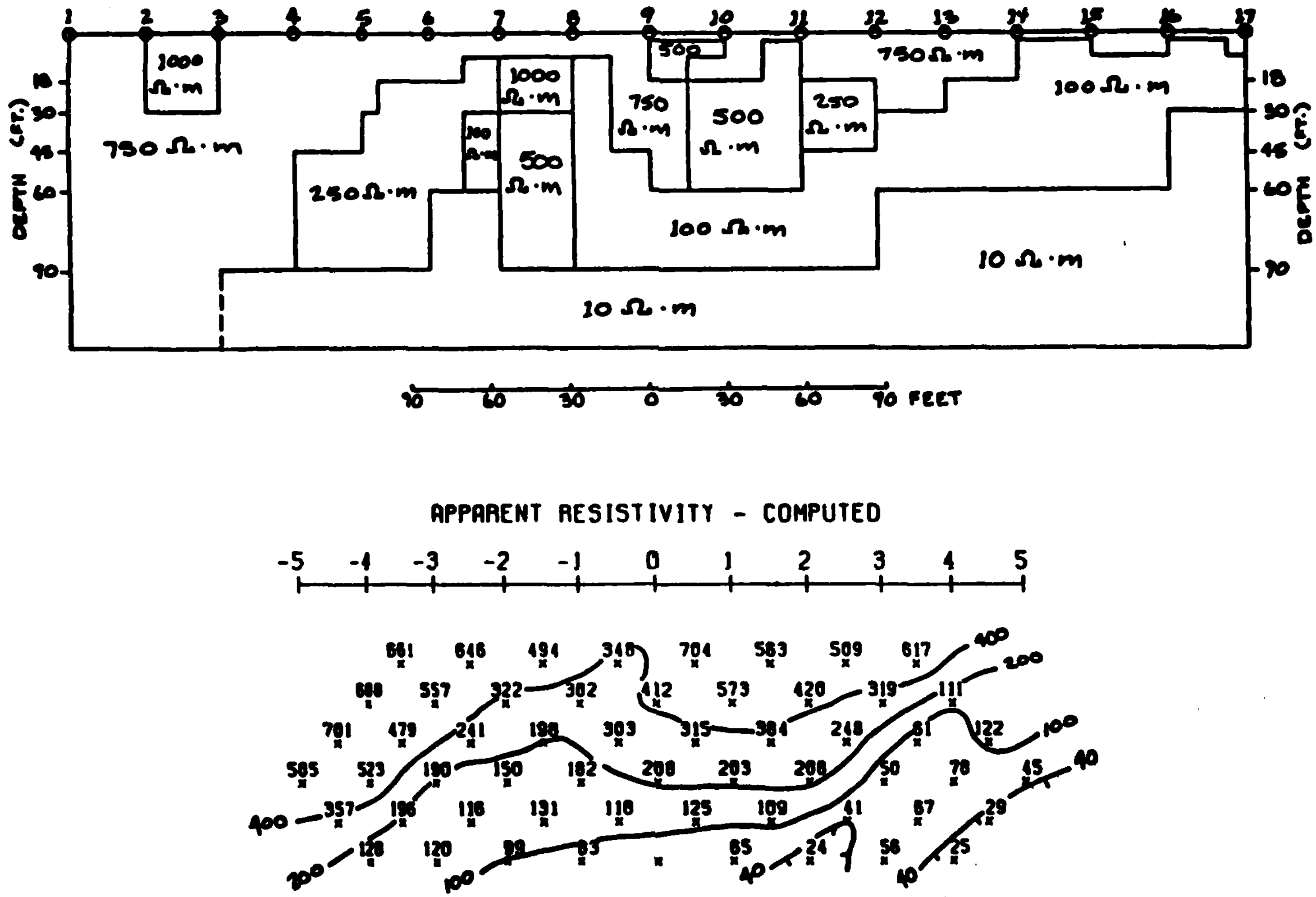


Figure G33 Computed Model
Line 1, Chemical Disposal
Pits 1 and 2
Hill Air Force Base, Utah

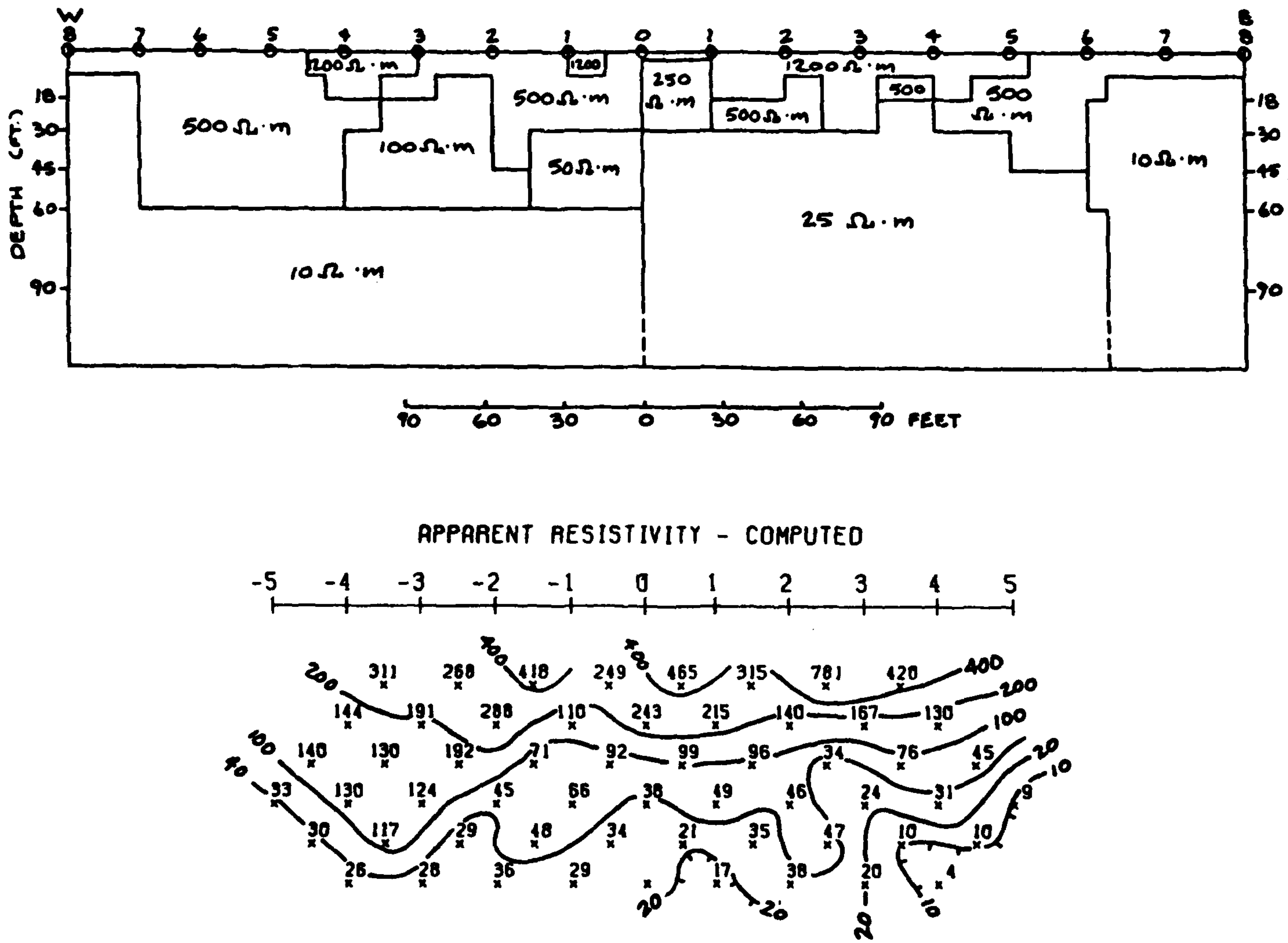


Figure G34 Computed Model
Line 2, Chemical Disposal
Pits 1 and 2
Hill Air Force Base, Utah

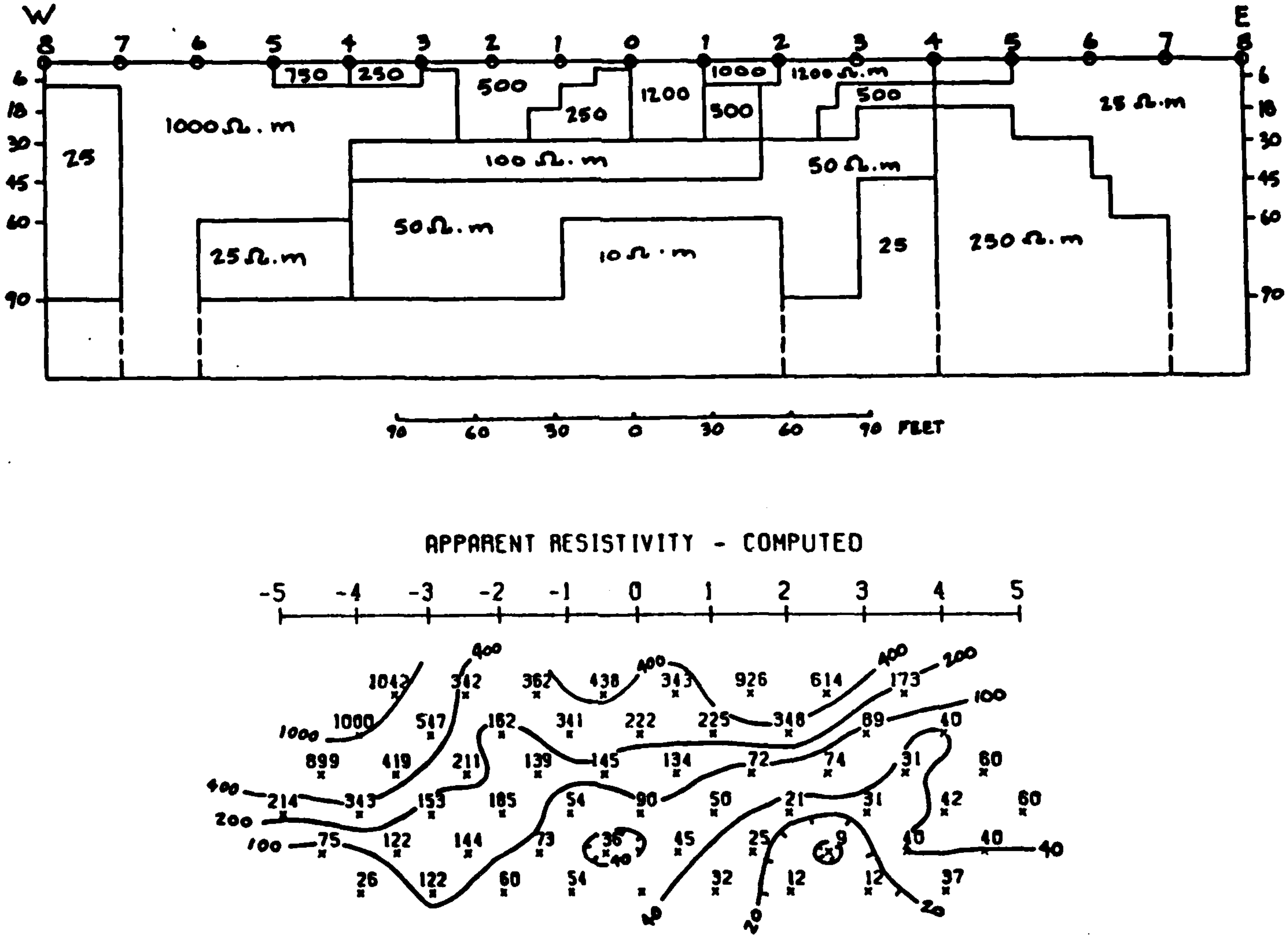


Figure G35 Computed Model
Line 3, Chemical Disposal
Pits 1 and 2
Hill Air Force Base, Utah

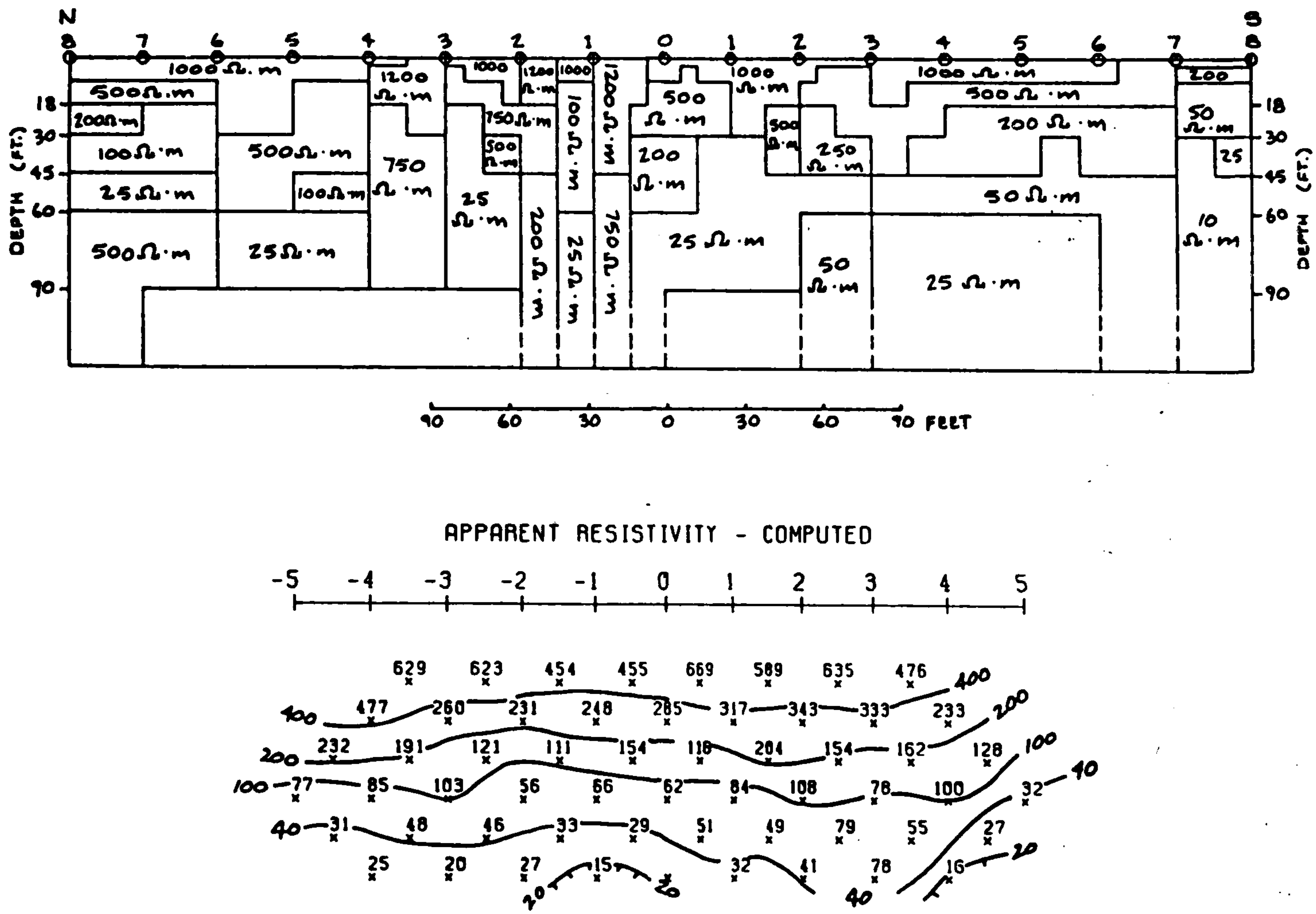


Figure G36 Computed Model
Line 5, Chemical Disposal
Pits 1 and 2
Hill Air Force Base. Utah

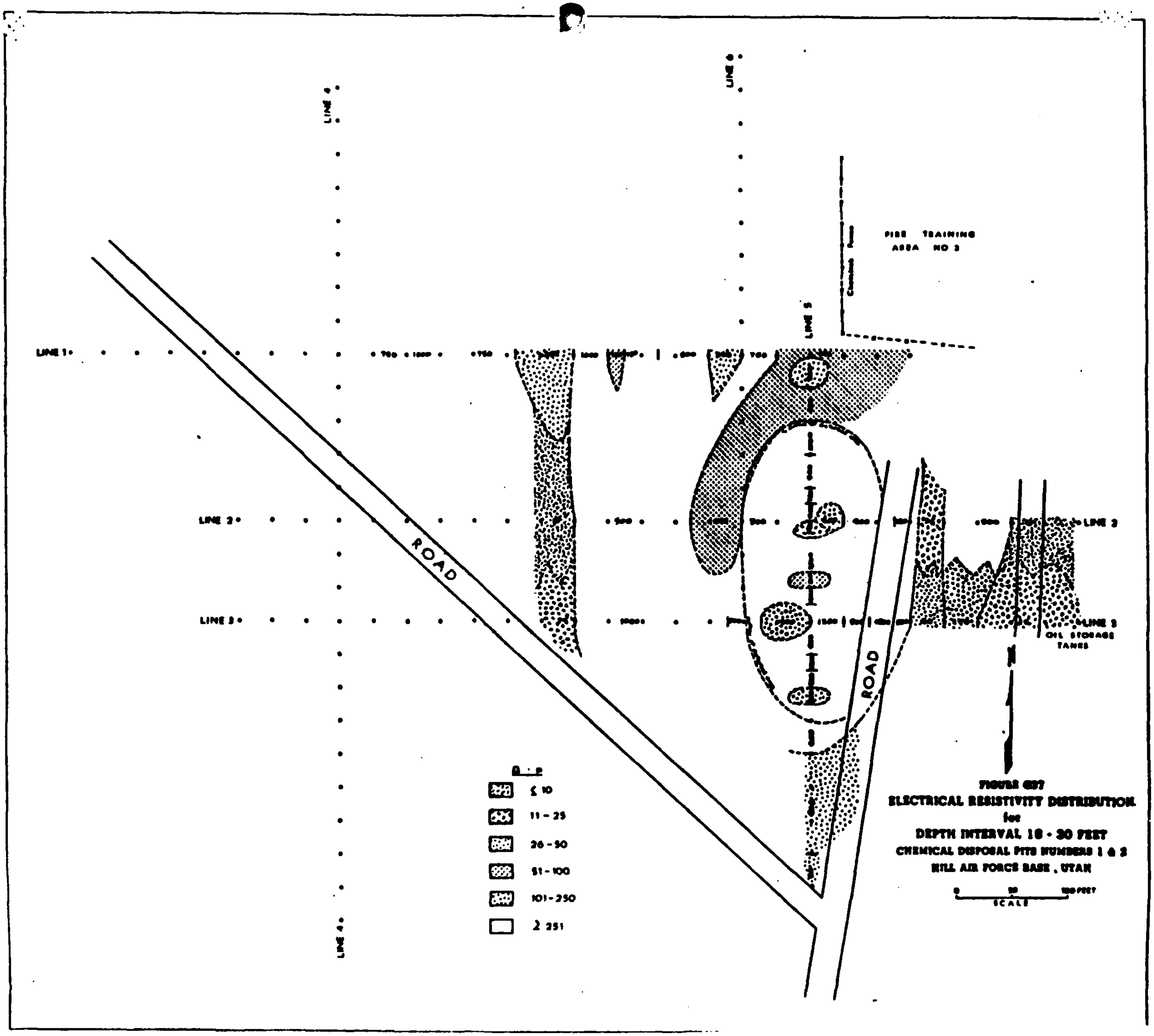


FIGURE G37
ELECTRICAL RESISTIVITY DISTRIBUTION
for
DEPTH INTERVAL 18 - 30 FEET
CHEMICAL DISPOSAL PITS NUMBERS 1 & 2
HILL AIR FORCE BASE, UTAH

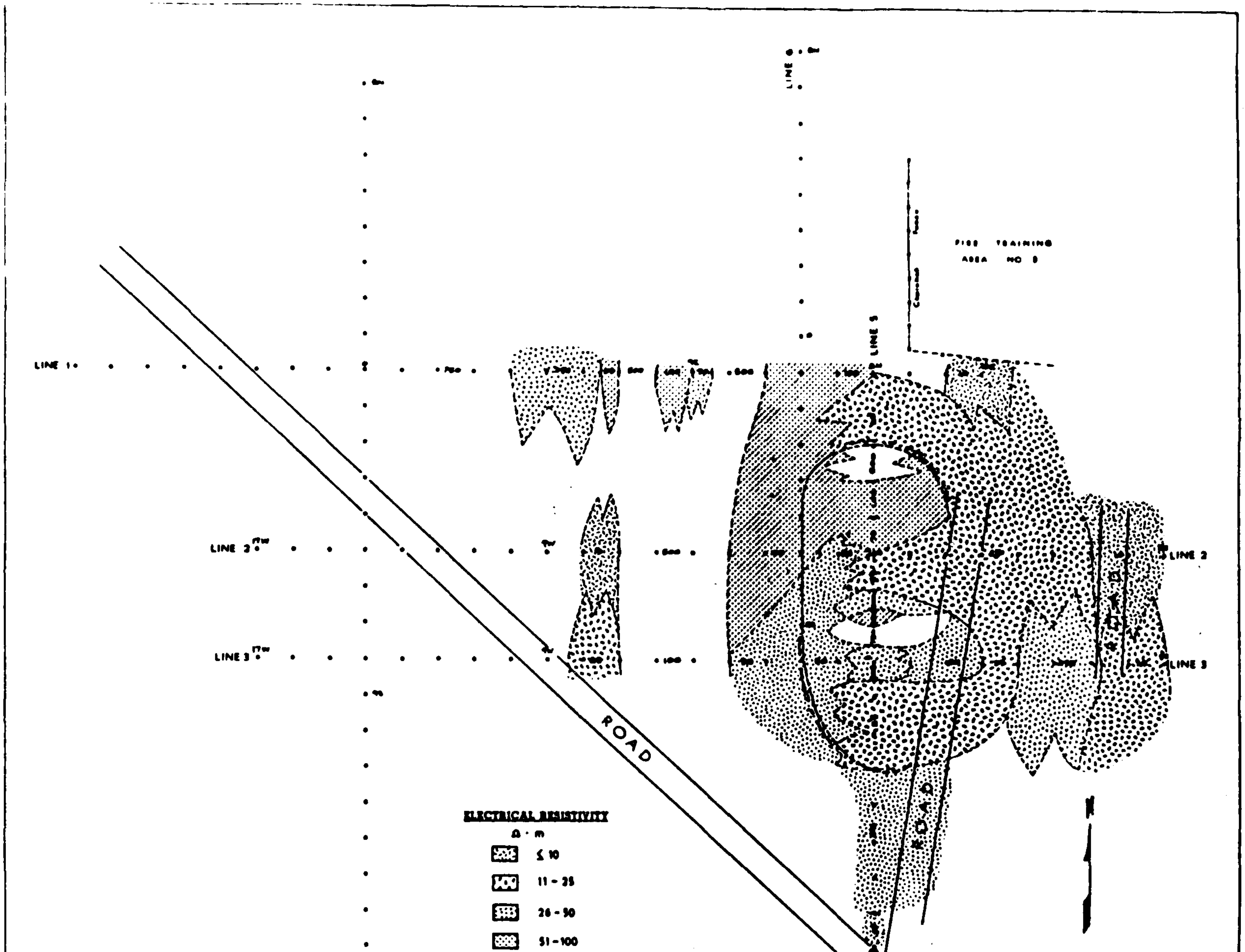


FIGURE G38

ELECTRICAL RESISTIVITY DISTRIBUTION
for
DEPTH INTERVAL 45 - 60feet
CHEMICAL DISPOSAL PITS NUMBERS 1 & 2
HILL AIR FORCE BASE, UTAH

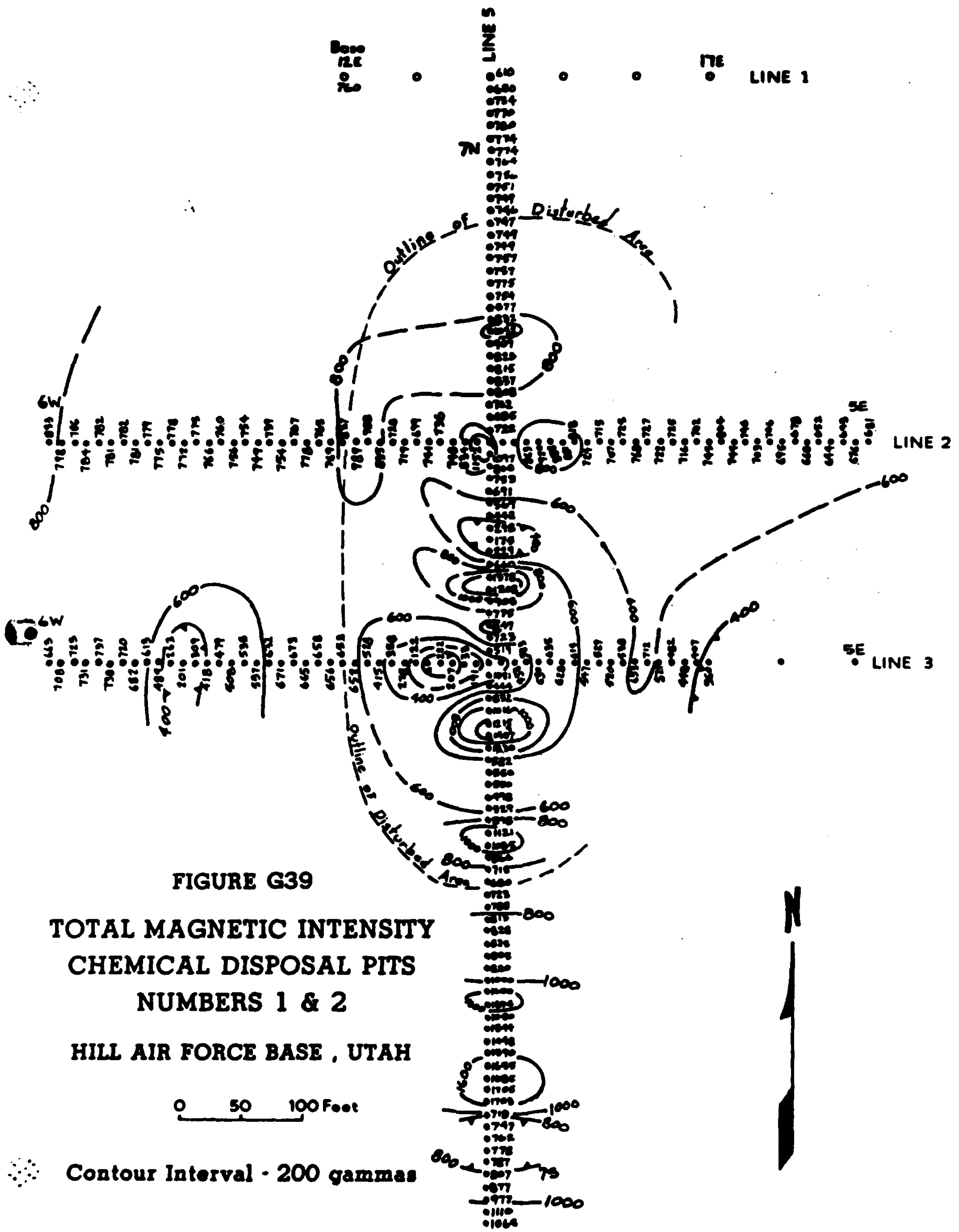


FIGURE G39

TOTAL MAGNETIC INTENSITY
CHEMICAL DISPOSAL PITS
NUMBERS 1 & 2

HILL AIR FORCE BASE , UTAH

0 50 100 Feet

Contour Interval - 200 gammas

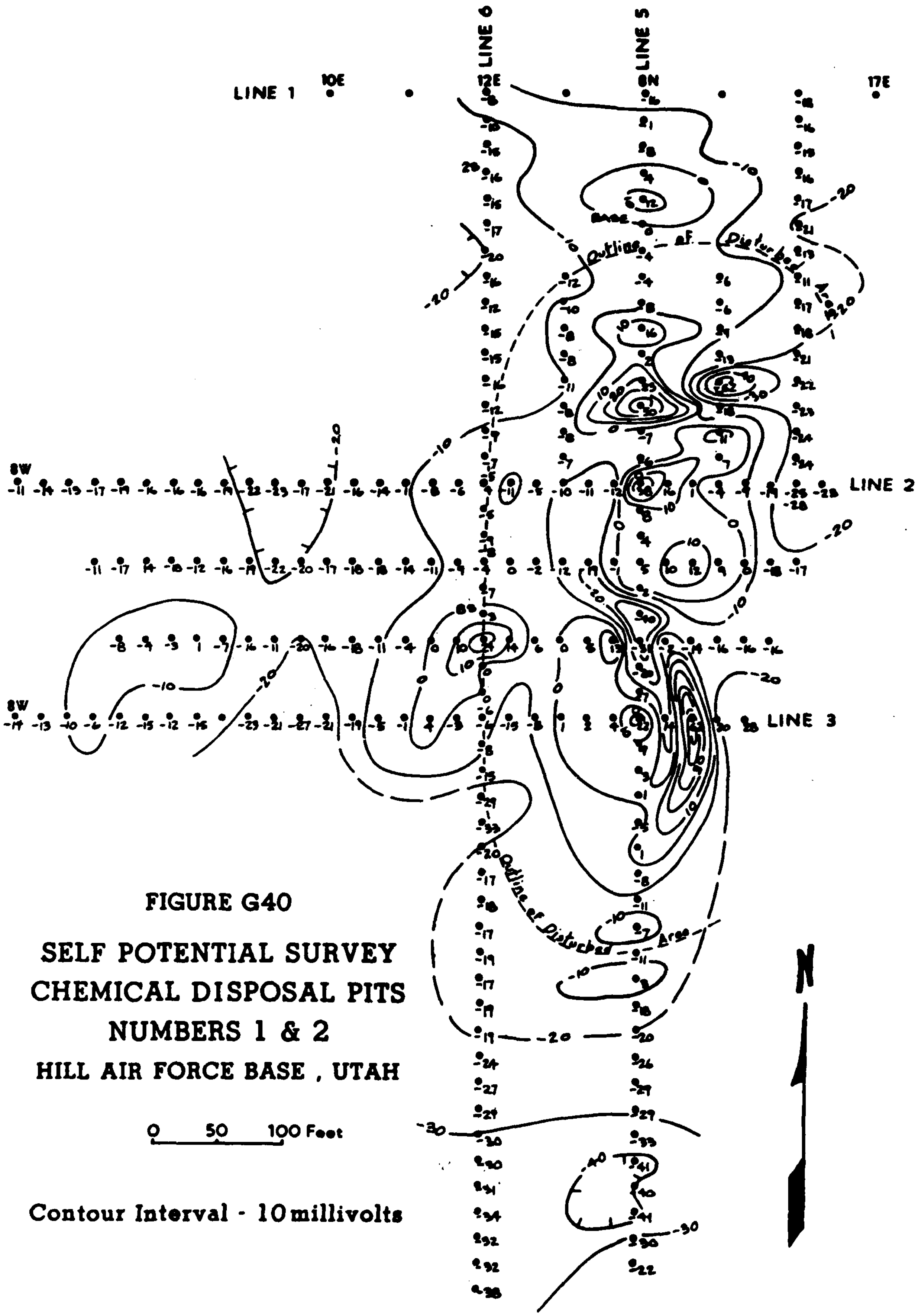


FIGURE G40

SELF POTENTIAL SURVEY CHEMICAL DISPOSAL PITS NUMBERS 1 & 2

HILL AIR FORCE BASE, UTAH

0 50 100 Feet

Contour Interval - 10 millivolts

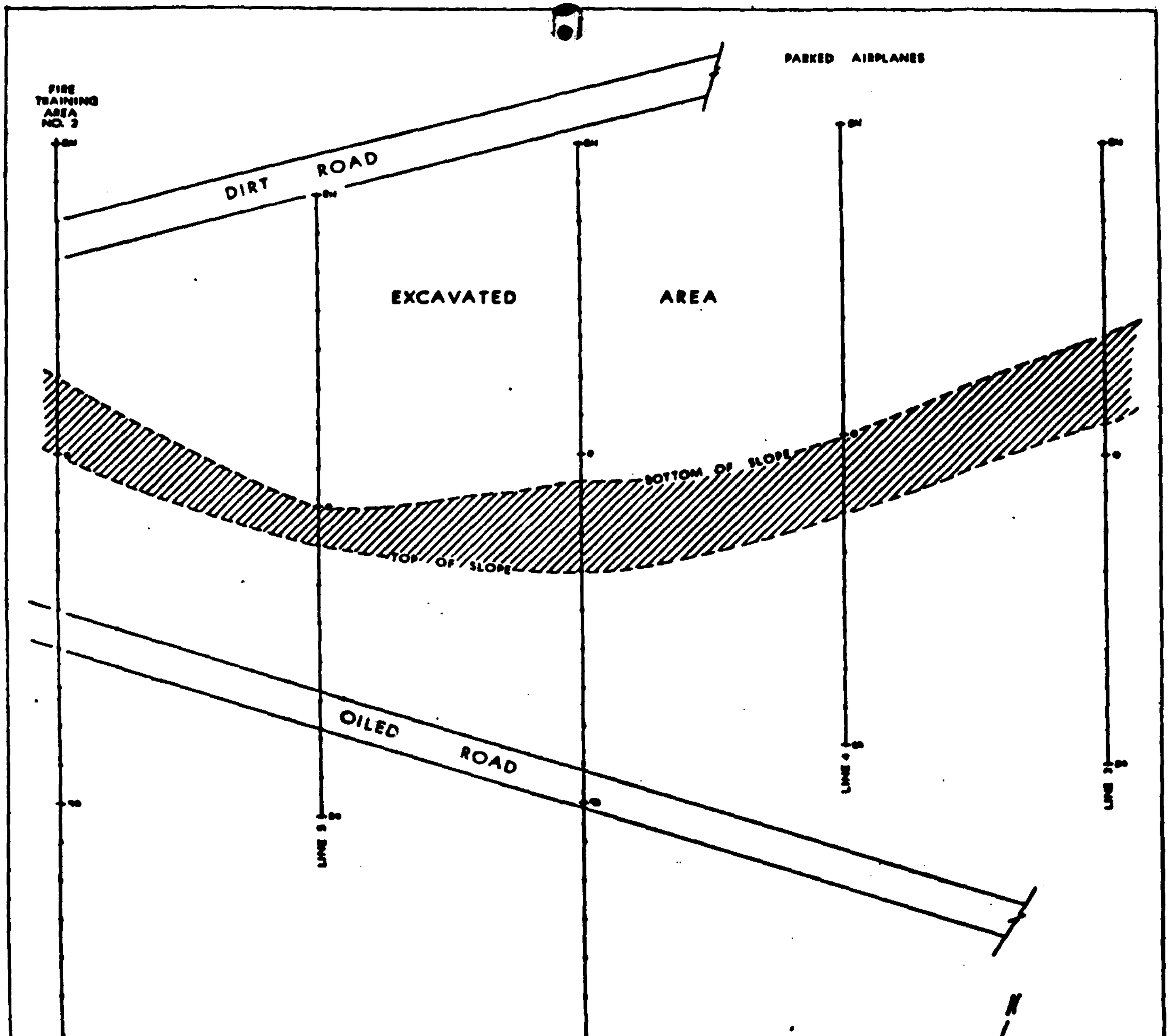
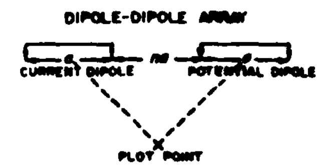
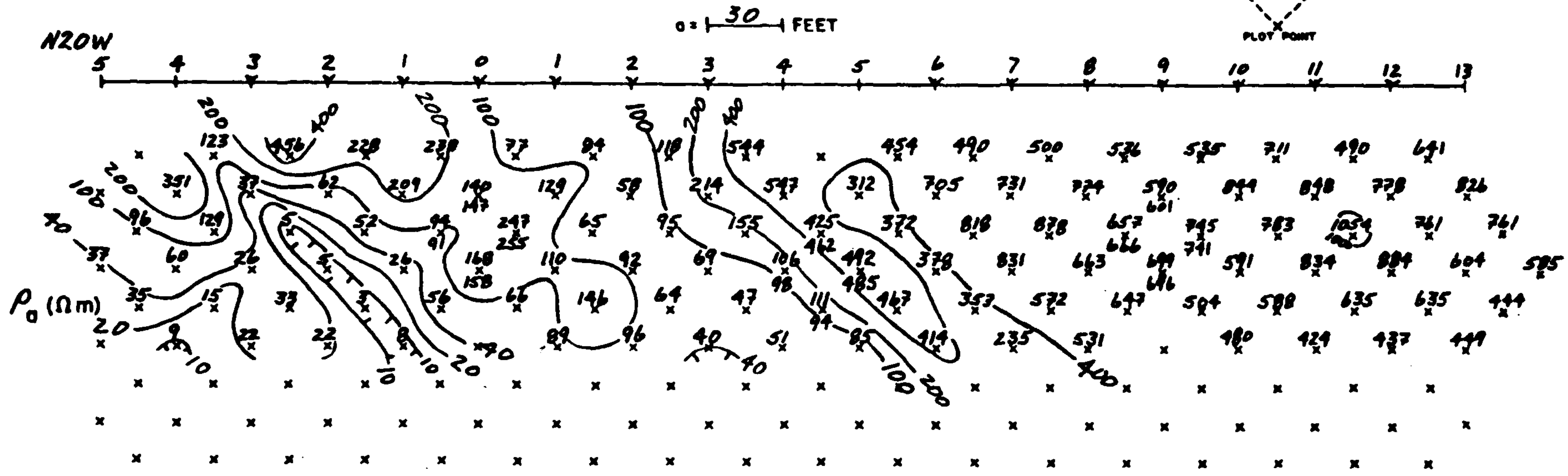


FIGURE G41
LINE LOCATION MAP
ELECTRICAL RESISTIVITY SURVEY
LANDFILL NUMBER 3
HILL AIR FORCE BASE, UTAH

EARTH SCIENCE LABORATORY
UNIVERSITY of UTAH RESEARCH INSTITUTE
DIPOLE - DIPOLE ARRAY
APPARENT RESISTIVITY





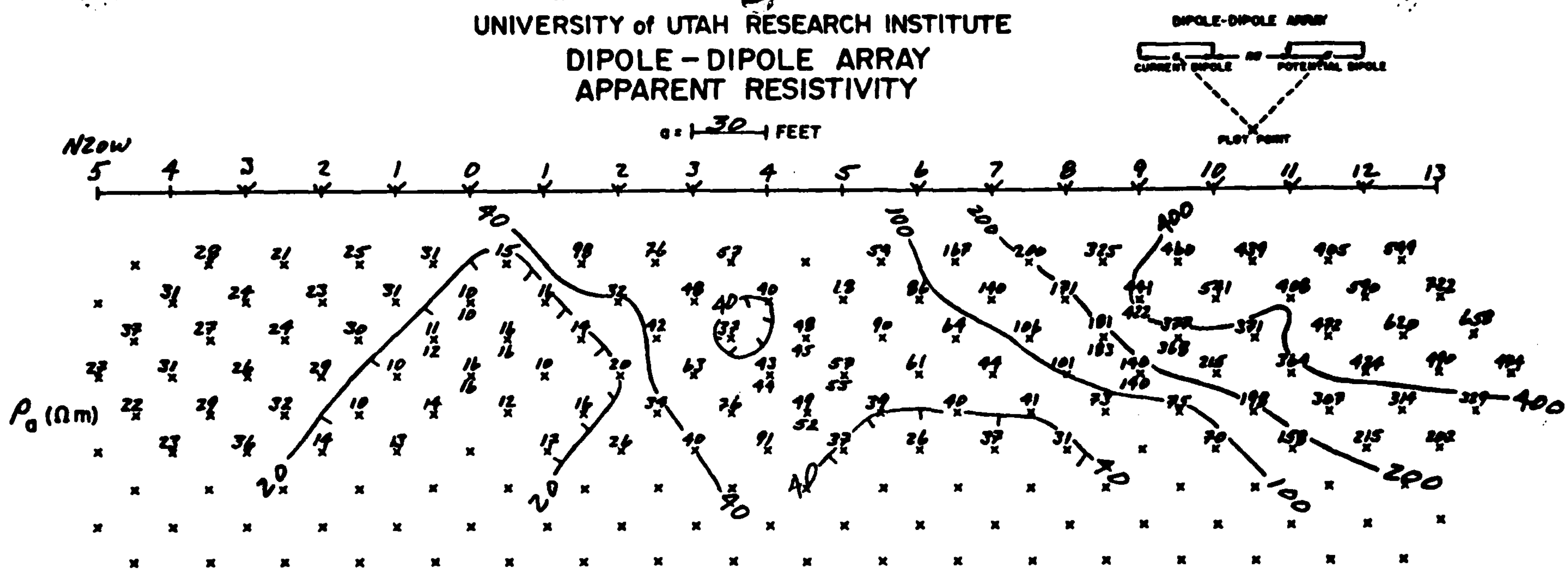
Note: Oiled road between sta 4-5SE
Edge of excavation between
sta 0-2NW

AREA LANDFILL NO. 3 STATE UTAH LINE 1 DATA BY CEM DATE 12/14/82 TRANSMITTER BISON RECEIVER BISON

FIGURE G42

EARTH SCIENCE LABORATORY
UNIVERSITY of UTAH RESEARCH INSTITUTE
DIPOLE – DIPOLE ARRAY
APPARENT RESISTIVITY

a = 30 FEET



AREA LANDFILL No. 3 HILL AFB STATE UTAH LINE 2 DATA BY CEM DATE 12/14/82 TRANSMITTER BISON RECEIVER BISON

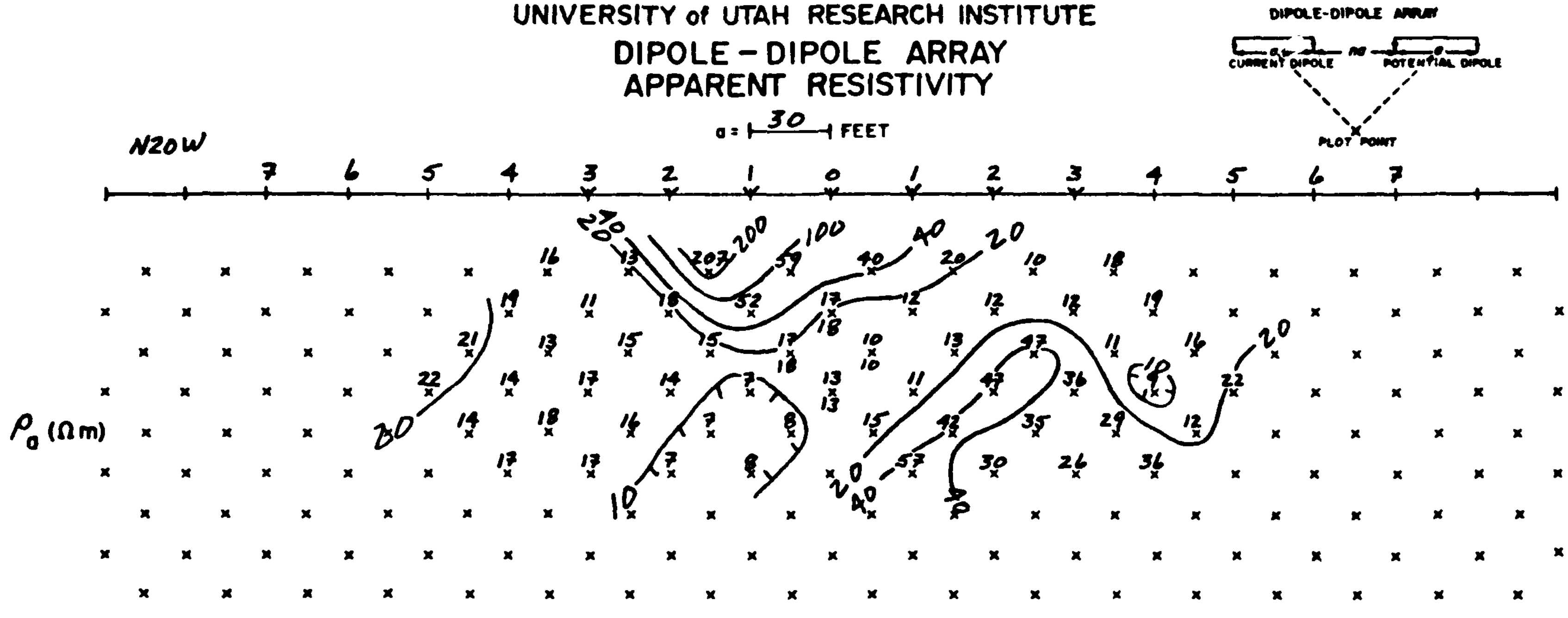
FIGURE G43

EARTH SCIENCE LABORATORY

UNIVERSITY of UTAH RESEARCH INSTITUTE

DIPOLE - DIPOLE ARRAY
APPARENT RESISTIVITY

a = 30 FEET



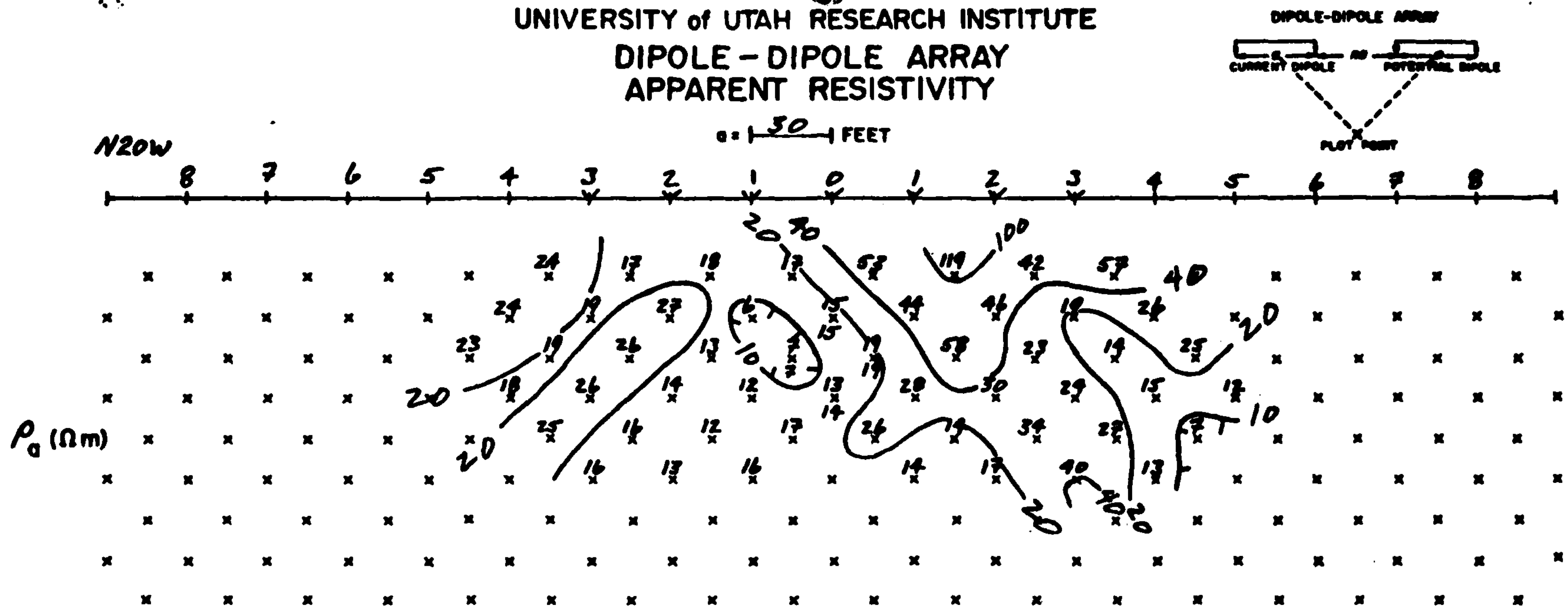
AREA LANDFILL No. 3 H L AFB STATE UTAH LINE 3 DATA BY CEM DATE 12/16/82 TRANSMITTER BISON RECEIVER BISON

FIGURE G44

EARTH SCIENCE LABORATORY
UNIVERSITY of UTAH RESEARCH INSTITUTE

DIPOLE - DIPOLE ARRAY
APPARENT RESISTIVITY

a = 30 FEET



G-45

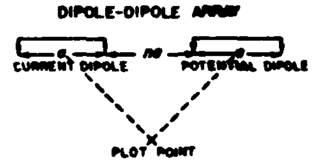
AREA LANDFILL No. 3 STATE UTAH LINE 4 DATA BY CEM DATE 12/17/82 TRANSMITTER BISON RECEIVER BISON

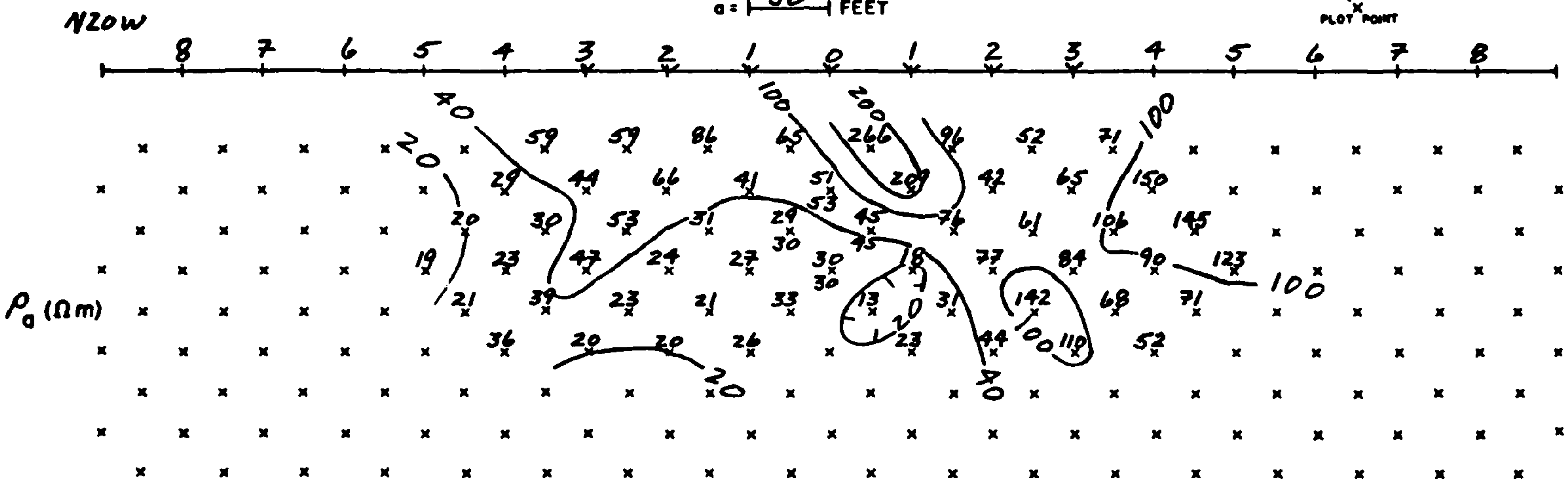
HILL AFB

FIGURE G45

EARTH SCIENCE LABORATORY
UNIVERSITY of UTAH RESEARCH INSTITUTE
DIPOLE - DIPOLE ARRAY
APPARENT RESISTIVITY

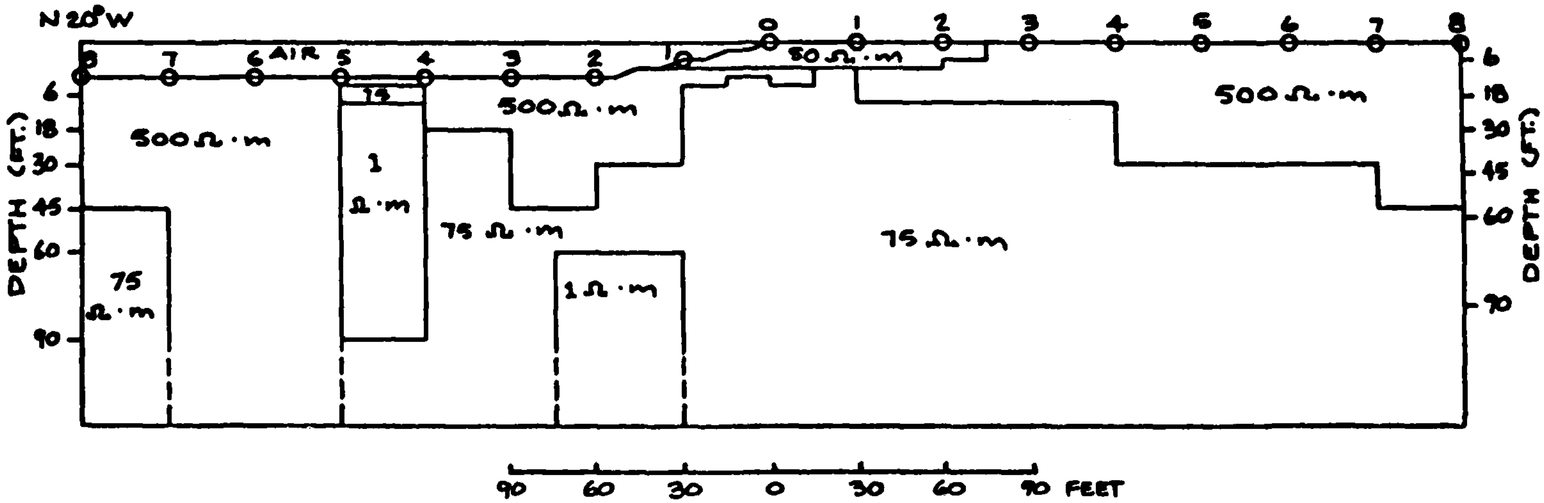
a = 30 FEET





AREA LANDFILL No. 3 STATE UTAH LINE 5 DATA BY CEM DATE 12/17/82 TRANSMITTER BISON RECEIVER BISON
ILL AFB

GURE G46



APPARENT RESISTIVITY - COMPUTED

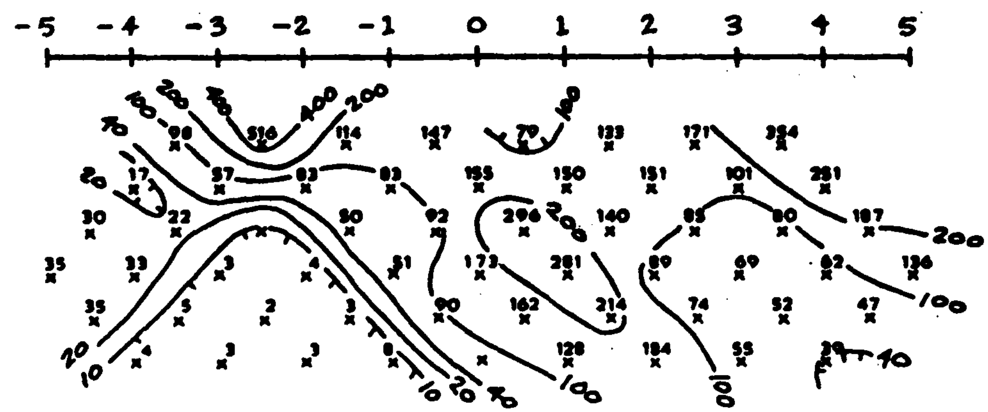


Figure G47 Computed Model
Line 1, Landfill No. 3
Hill Air Force Base, Utah

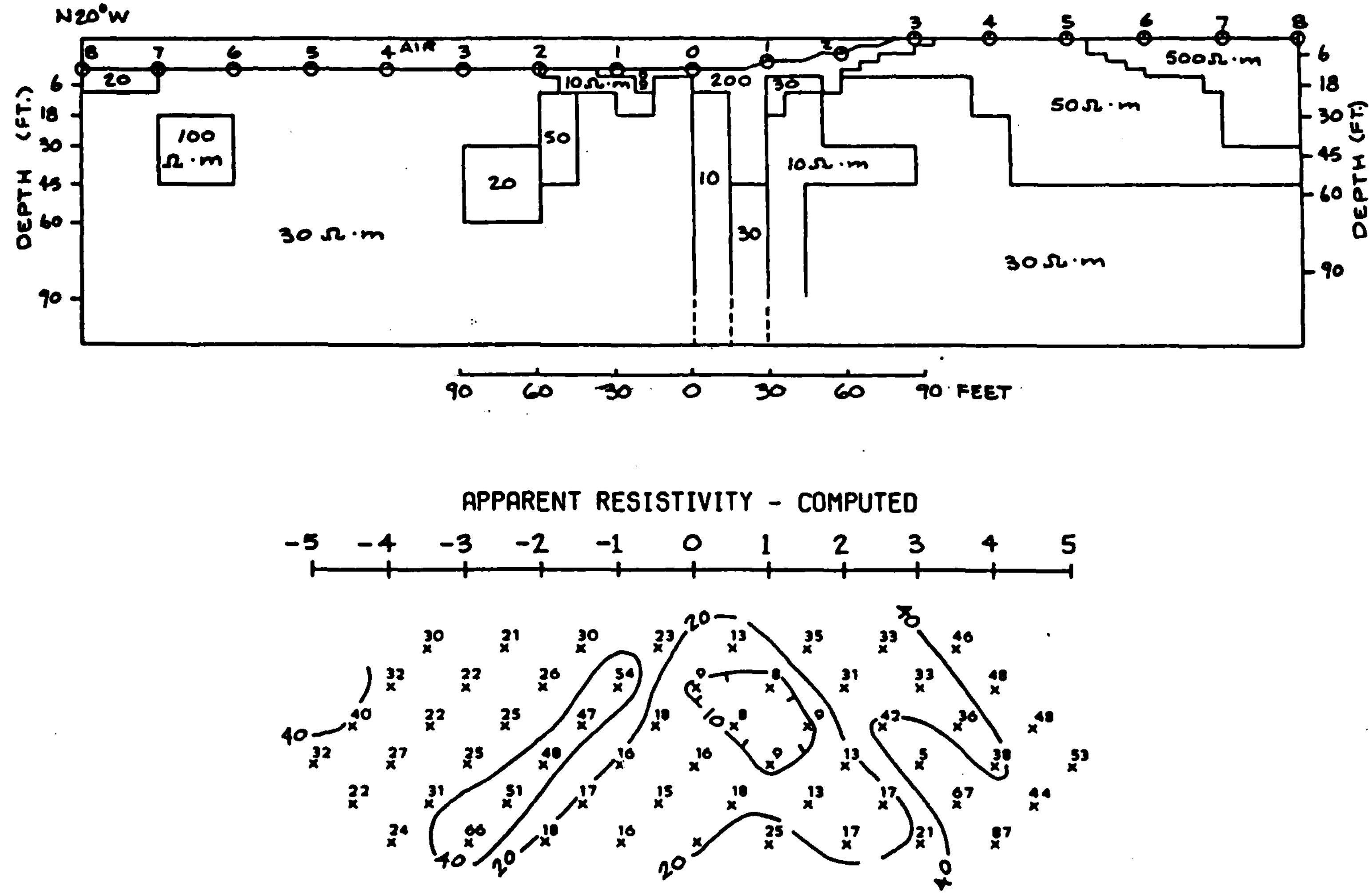


Figure G48 Computed Model
Line 2, Landfill No. 3
Hill Air Force Base, Utah

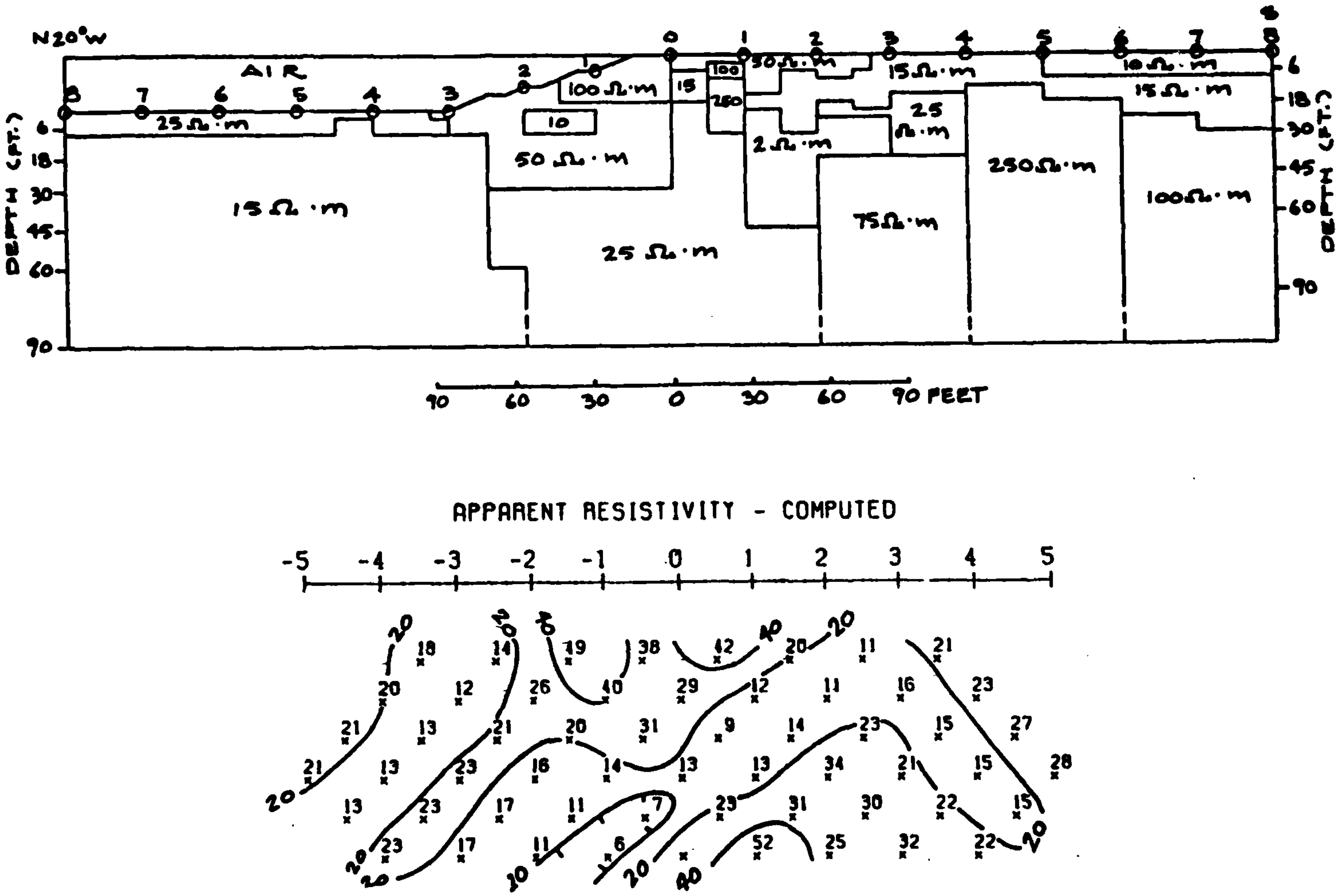


Figure G49 Computed Model
Line 3, Landfill No. 3
Hill Air Force Base, Utah

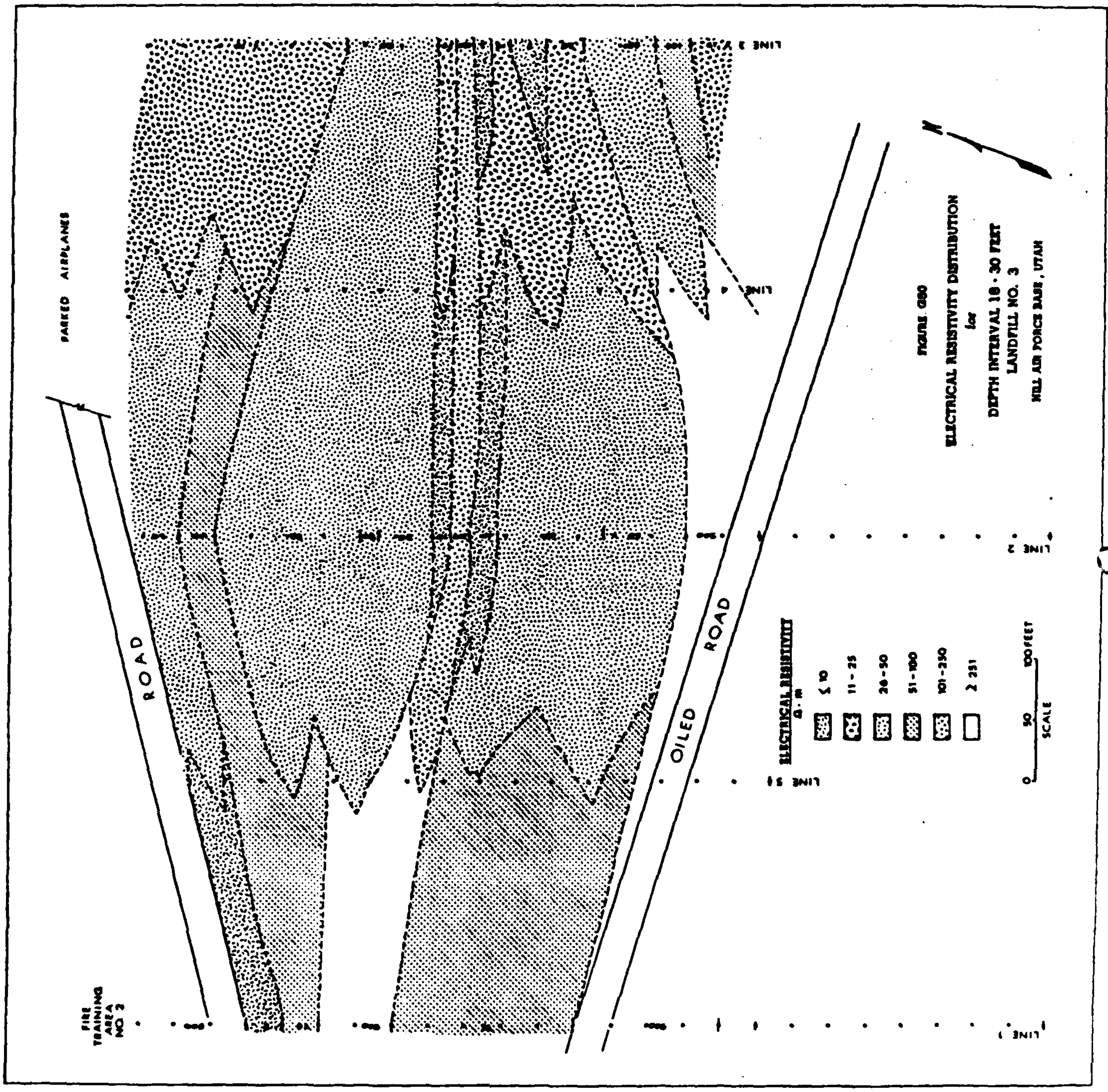


FIGURE G80
ELECTRICAL RESISTIVITY DISTRIBUTION
for
DEPTH INTERVAL 18 - 30 FEET
LANDFILL NO. 3
HILL AIR FORCE BASE, UTAH

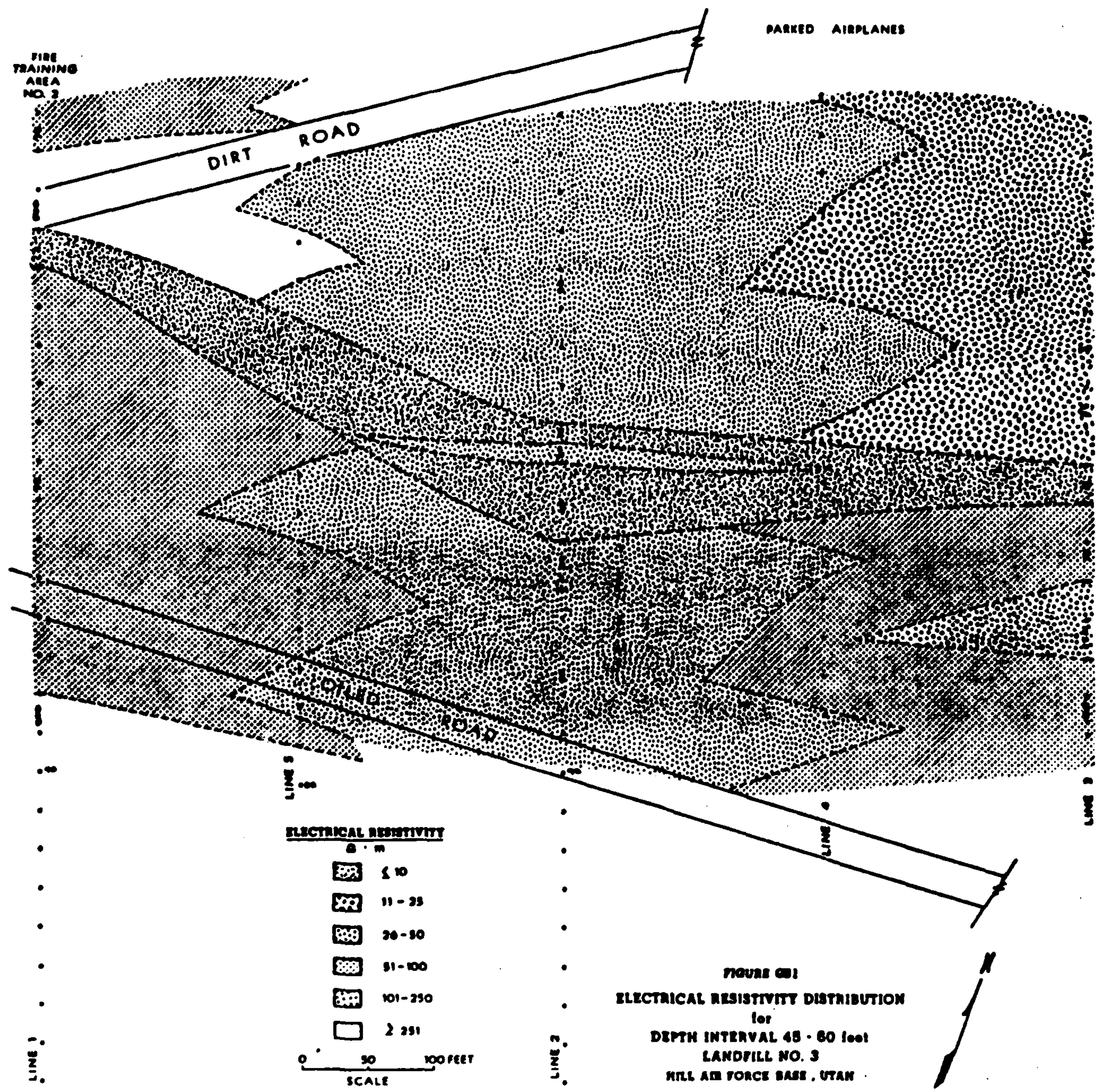


FIGURE G[illegible]

ELECTRICAL RESISTIVITY DISTRIBUTION
for
DEPTH INTERVAL 45 - 60 feet
LANDFILL NO. 3
HILL AIR FORCE BASE, UTAH

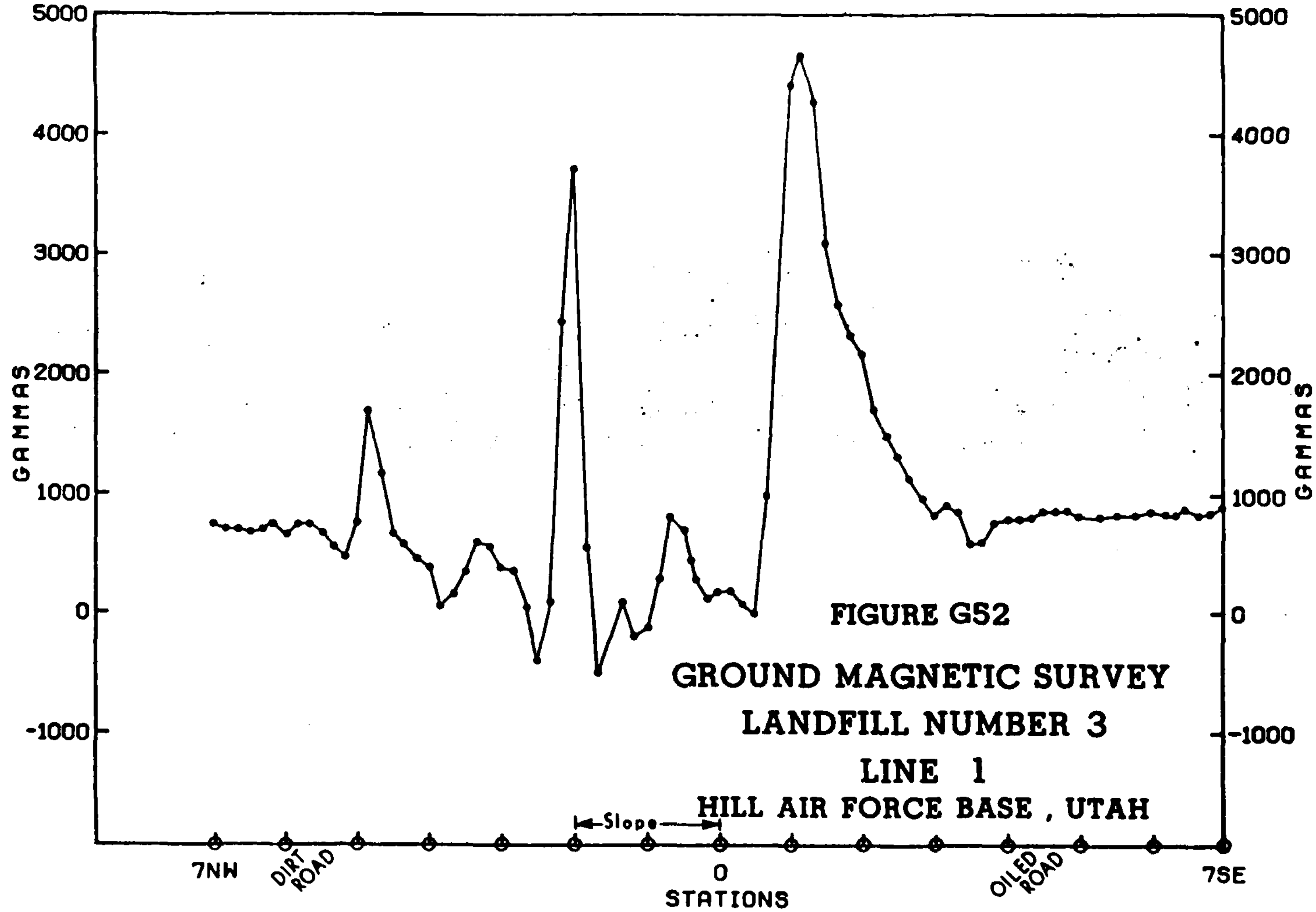


FIGURE G52

GROUND MAGNETIC SURVEY
LANDFILL NUMBER 3
LINE 1
HILL AIR FORCE BASE , UTAH

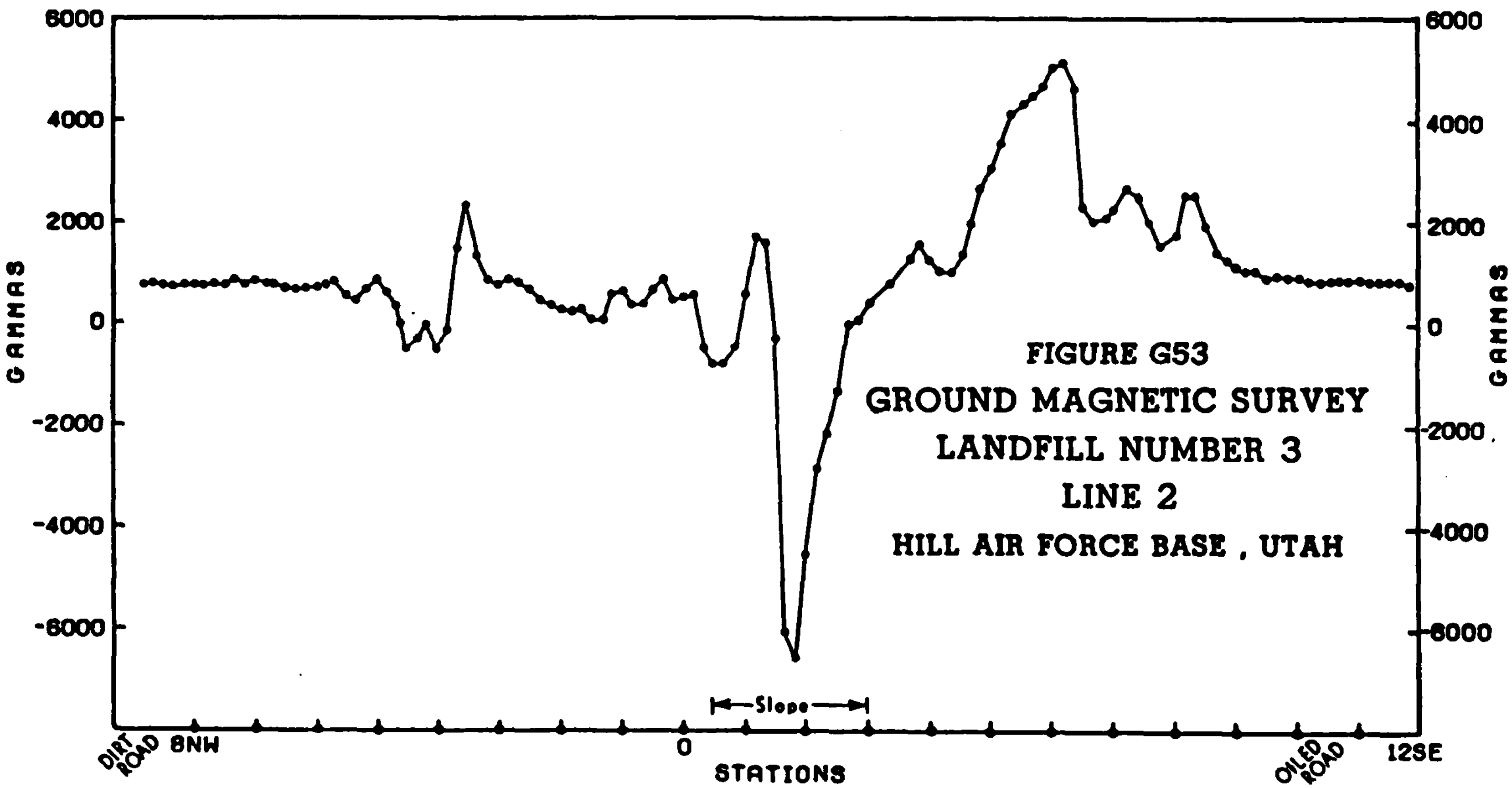


FIGURE G53
GROUND MAGNETIC SURVEY
LANDFILL NUMBER 3
LINE 2
HILL AIR FORCE BASE , UTAH

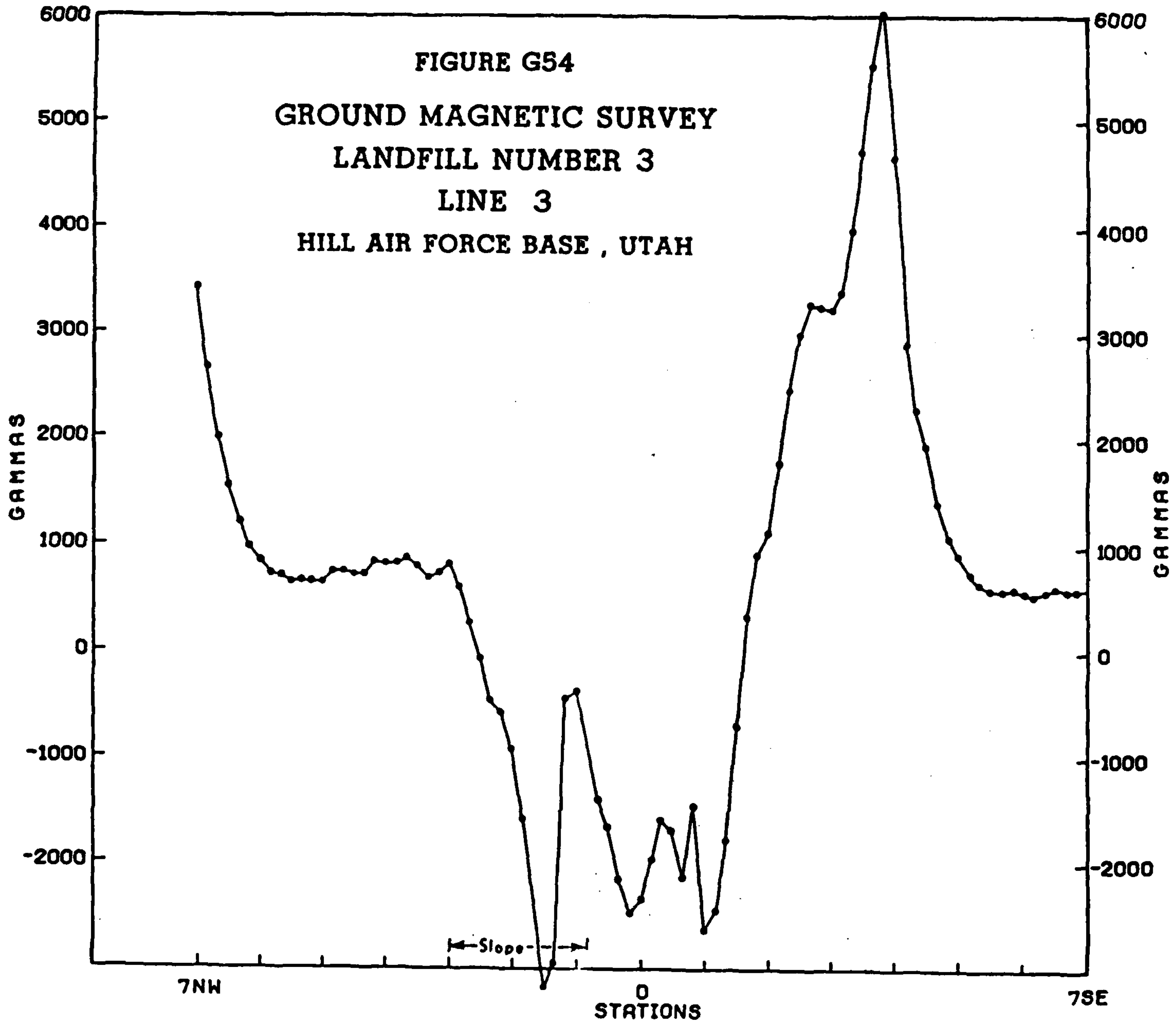


FIGURE G54
GROUND MAGNETIC SURVEY
LANDFILL NUMBER 3
LINE 3
HILL AIR FORCE BASE , UTAH
GAMMAS
6000
5000
4000
3000
2000
1000
0
-1000
-2000
7NW
0
STATIONS
7SE
Slope

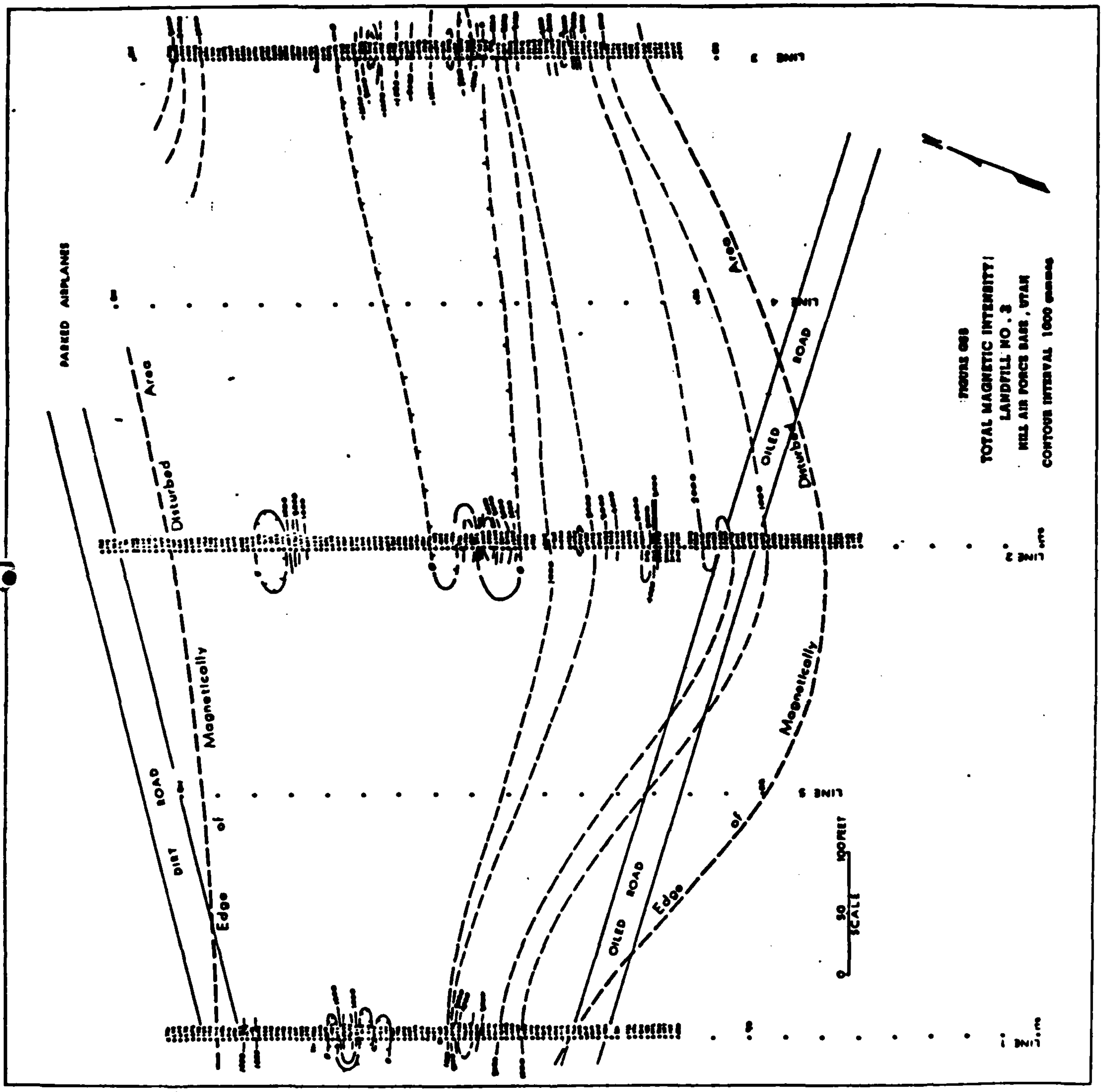
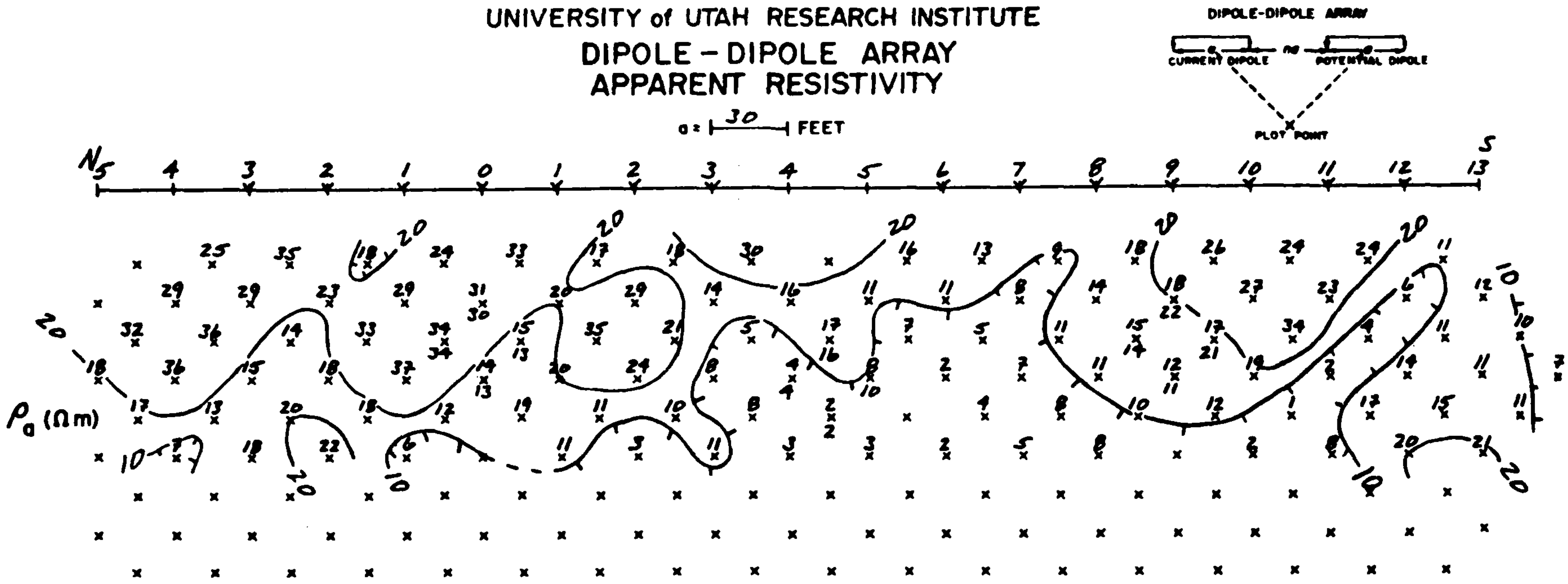


FIGURE G58
TOTAL MAGNETIC INTENSITY
LANDFILL NO. 3
HILL AIR FORCE BASE, UTAH
CONTOUR INTERVAL 1000 gammas

EARTH SCIENCE LABORATORY
UNIVERSITY of UTAH RESEARCH INSTITUTE
DIPOLE - DIPOLE ARRAY
APPARENT RESISTIVITY

a = 30 FEET



Note: sta 8N is 265'E of road to maintenance building and 50'S of road to Club House

AREA Golf Course STATE UTAH LINE 1 DATA BY CEM DATE 12/22/82 TRANSMITTER BISON RECEIVER BISON

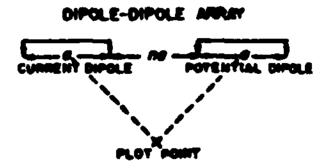
L AFB

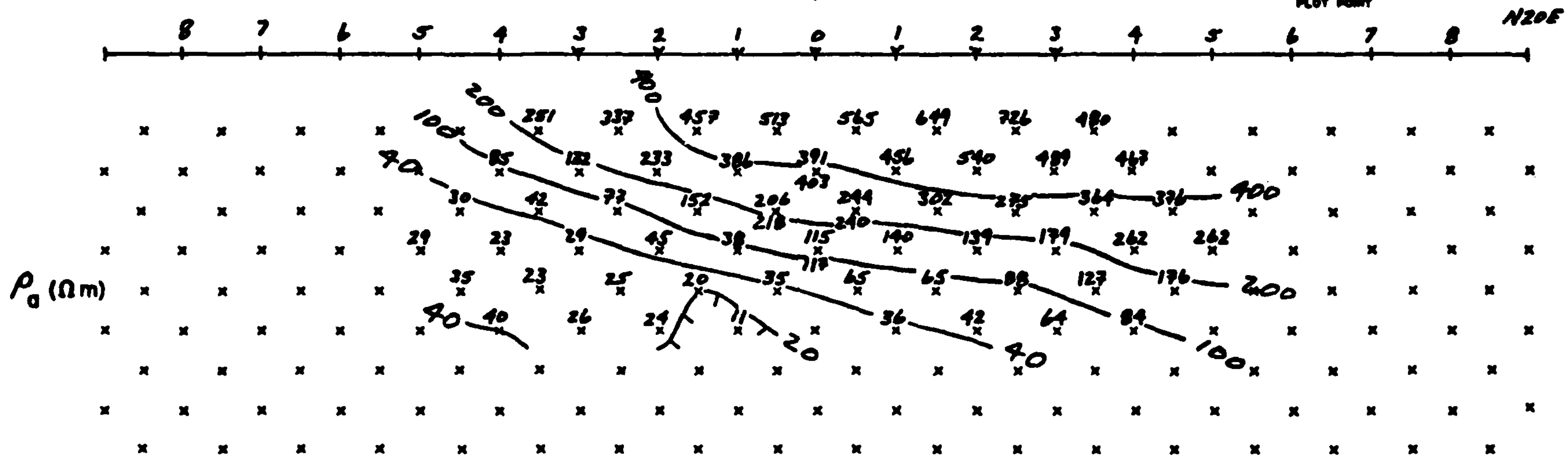
FIGURE G56

EARTH SCIENCE LABORATORY
UNIVERSITY of UTAH RESEARCH INSTITUTE

DIPOLE - DIPOLE ARRAY
APPARENT RESISTIVITY

a = 30 FEET





Note: sta 0 is 100'W of road junction
at Fouldis Drive and Sage St.

AREA BASE WELL No. 4 HILL AFB STATE UTAH LINE 1 DATA BY CEM DATE 12/22/82 TRANSMITTER BISON RECEIVER BISON

FIGURE G57

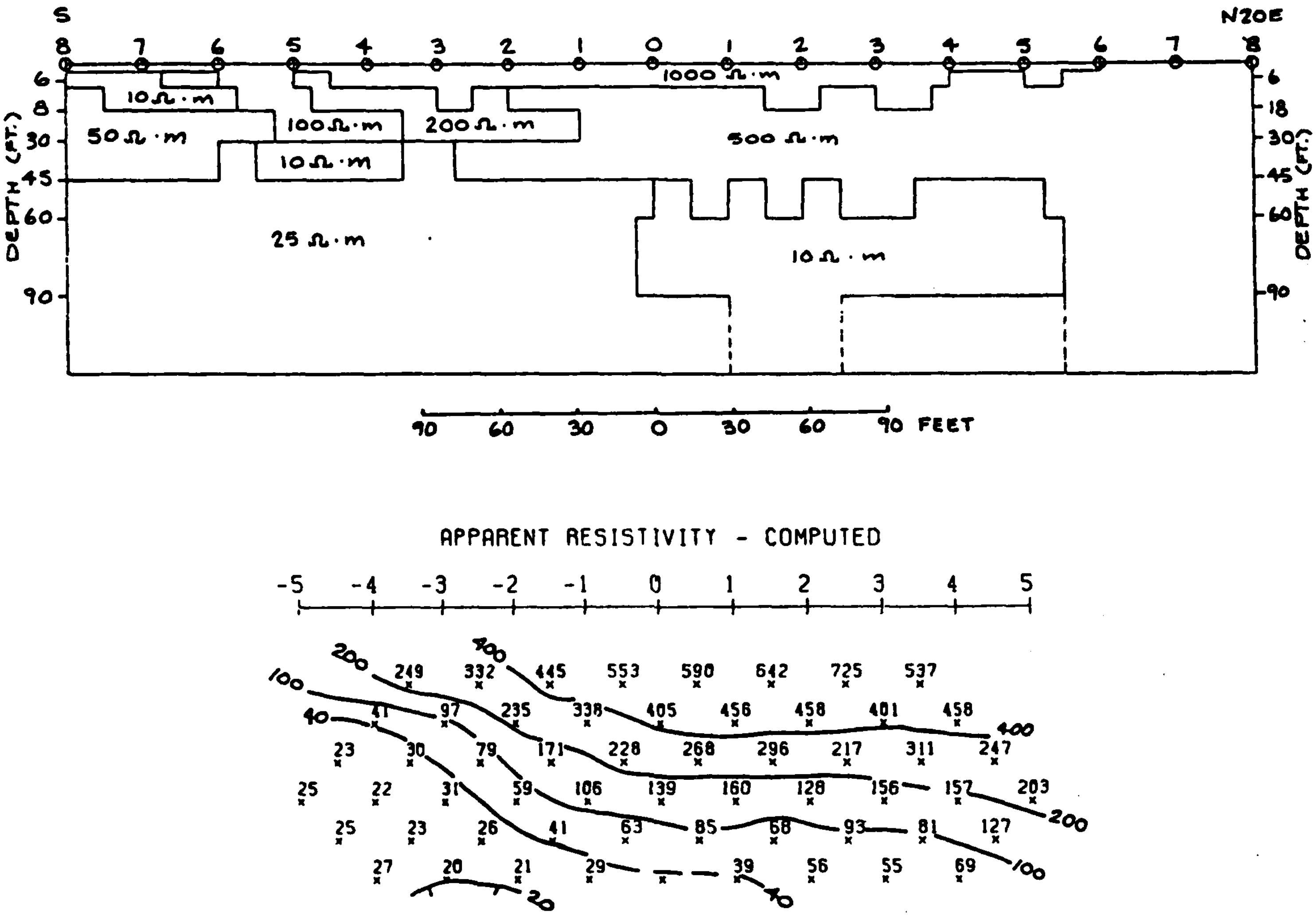


Figure G58 Computed Model
Line 1, Base Well No. 4
Hill Air Force Base, Utah

APPENDIX H: BIOGRAPHIES OF KEY PERSONNEL
(pp. H-1 through H-58)

- UBTL Division, *University of Utah Research Institute*
  - Sim D. Lessley
  - A. Brent Torgensen
  - Edward H. Sanders

- *Radian Corporation*
  - Rick A. Belan
  - Robert Vandervort
  - Ann E. St. Clair
  - William M. Little
  - Jerry L. Parr
  - Donald H. Rodgers
  - Fred B. Blood

- Earth Science Laboratory, University of Utah Research Institute
  - Howard P. Ross
  - Claron E. Mackelprang

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  - William M. Little
  - Jerry L. Parr
  - Donald H. Rodgers
  - Fred B. Blood

- Earth Science Laboratory, University of Utah Research Institute
  - Howard P. Ross
  - Claron E. Mackelprang

CURRICULUM VITAE

LESSLEY, Sim D.
Technical Manager and Inorganic Chemistry Section Head, UBTL Division, University of Utah Research Institute, Salt Lake City, Utah.

PII Redacted

[redacted]

Education

B.A.	Linfield College, McMinnville, Oregon, 1967 Major: Chemistry
M.S.	University of Utah, Salt Lake City, Utah, 1975 Major: Inorganic Chemistry
Ph.D.	University of Utah, Salt Lake City, Utah, 1980 Major: Inorganic Chemistry

Experience

1/83-Present — UBTL Division, University of Utah Research Institute, Salt Lake City, Utah

Head, Inorganic Chemistry Section, Chemistry Department

Responsibilities: Management of an industrial hygiene and environmental chemistry laboratory section employing 15 persons. Responsible for coordination of chemical analyses, equipment procurement and maintenance, methods development, laboratory protocols, documentation of samples and sample analysis reports.

2/82-Present — UBTL Division, University of Utah Research Institute, Salt Lake City, Utah.

Technical Manager, Chemistry Department

Responsibilities: Project management, proposal preparation, report writing, personnel recruitment and problem solving. Assist as requested with quality control, development and evaluation of analytical methods and laboratory automation.

8/80– 2/82 UBTL Division, University of Utah Research Institute, Salt Lake City, Utah.

Head, Organic Chemistry Section

Responsibilities: Management and supervision of chemistry activities, proposal and report writing. Supervision of an industrial hygiene and environmental chemistry laboratory section employing 16 persons. Responsible for coordinating chemical analysis of commercial and contract samples, equipment procurement and maintenance, methods development, coordination of laboratory sampling protocol, documentation of samples and sample analysis reports.

9/75– 8/80 UBTL Division, University of Utah Research Institute, Salt Lake City, Utah.

Analytical Chemist

Responsibilities: Developing, evaluating, and performing trace analytical procedures. Work includes operation and some maintenance of manual and automatic gas chromatographs, liquid chromatographs, X-ray powder diffractometer, atomic absorption spectrophotometer, and automatic titrator. Various titrimetric, colorimetric, and gravimetric methods are also used.

The methods which have been developed include a gas chromatographic determination of substituted phenols in blood and urine, and an automatic titrimetric determination of sulfate, a gas chromatographic method for caprolactam and an HPLC method for seven aliphatic isocyanates.

May 1979 – August 1980 have served as Organic Chemistry Group Leader.

9/75– 5/76 Chemistry Department, University of Utah, Salt Lake City, Utah.

Instructor, High School Advanced Placement Chemistry Laboratory

Responsibilities: Lectures, laboratory supervision, and grading. Involved in curriculum development.

9/70– 9/75 Chemistry Department, University of Utah, Salt Lake City, Utah

Graduate Student/Teaching Assistant

Responsibilities: Laboratories and/or discussions in: Physical Chemistry, Wet Analytical Chemistry, Instrumental Analysis, Inorganic Synthesis and General Chemistry.

Research has involved synthesis and handling of air and moisture sensitive compounds, extensive NMR work, IR, X-ray, UV-Vis, computer operation and some computer programming.

10/68- 9/70 Letterman Army Institute of Research, Presidio of San Francisco (U.S. Army), San Francisco, California.

Chemical Laboratory Assistant

Responsibilities: Implemented a blood cortisol analysis, developed a peptide radioimmunoassay, worked on the purification and characterization of renin, an enzyme involved in the regulation of blood pressure.

Publications

STEPHENS, R.S.; Lessley, S.D.; and Ragsdale, R.O. (1970): A florine-19 NMR study of some BF_3 adducts. Inorganic Chemistry 10:1610.

LESSLEY, S.D. and Ragsdale, R.O. (1976): Acidities of some binary halidies. J of Chemical Education 53:19.

LESSLEY, S.D. (1980): Adducts of germanium tetrafluoride. (Ph.D. dissertation.)

LESSLEY, S.D. and White, K.L. (1983): Sampling and analysis in support of CR demilitarization. (Report prepared for U.S. Army, Tooele Army Depot.)

LESSLEY, S.D. and White, K.L. (1983): Sampling and analytis in support of CS and red smoke demilitarization. (Report prepared for U.S. Army, Tooele Army Depot.

CURRICULUM VITAE

TORGENSEN, A. Brent
Group Leader, UBTL Division, University of Utah Research Institute, Salt Lake City, Utah.

PII Redacted [redacted]

Education

B.S. Southern Utah State College, Cedar City, Utah (1971)
Major: Chemistry Minor: Mathematics

Areas of Specialization

Gas Chromotography, ECD, FPD, NPD, FID
Atomic Absorption Spectrophotometry
Specific Ion Electrometry
Technicon Auto-Analyzer II
Total Carbon Analyzer
Quality Control
Method Development

Experience

Oct 1981–Present — Chemistry Department, UBTL Division, University of Utah Research Institute, Salt Lake City, Utah.

Group Leader

Responsibilities: Responsible for supervision of analyses of all water samples received by the laboratory.

Sept 1979–Sept 1981 — Chemistry Department, UBTL Division, University of Utah Research Institute, Salt Lake City, Utah.

Analytical Chemist

Responsibilities: Responsible for water quality and environmental analysis of pesticides and PCB's.

Nov 1974–Sept 1979 — Ford Chemical Laboratory, Salt Lake City, Utah.

Supervisor

Responsibilities: Responsible for supervision of analyses on all water samples received by the laboratory.

PREVIOUS PAGE IS BLANK

July 1972- June 1973

Sevier School District, Richfield, Utah.

Secondary School Teacher

Responsibilities: Responsible for teaching courses in chemistry, mathematics, physics, and earth sciences.

CURRICULUM VITAE

SANDERS, Edward Henry
Analytical Chemist, UBTL Division, University of Utah Research Institute,
Salt Lake City, Utah.

PII Redacted [redacted]

Education

B.S.	1967	North Texas State University Chemistry (Physics - minor)
M.S.	1969	North Texas State University Chemistry (Mathematics - minor)
Ph.D.	1976	University of Utah Chemistry (Biology - minor)

Experience

June 1979- Present — Chemistry Department, UBTL Division, University of Utah Research Institute, Salt Lake City, Utah.

Organic Chemistry Section Manager

Responsibilities: Analysis and evaluation of industrial hygiene samples and environmental samples, including priority pollultants, and pesticides in water.

Jan 1976- May 1979 — Biology Department, University of Utah, Salt Lake City, Utah.

Postdoctoral Fellow

Responsibilities: Independent research and collaboration with biology faculty.

Mar 1971- Dec 1975 — Biology Department, University of Utah, Salt Lake City, Utah.

Research Fellow

Responsibilities: Independent doctoral research.

June 1969- Mar 1971 U.S. Army Air Defense Board, U.S. Army Test and Evaluation Command

Physical Science Advisor

Responsibilities: Design and evaluation of testing of ground to air defense systems.

Oct 1963- Jun 1969 Chemistry Department, North Texas State University, Denton, Texas

Teaching Assistant

Responsibilities: Preparation and instruction of laboratory exercises in organic and biochemical analysis.

Publications

NORTON, S.J. and E.H. Sanders (1967): DL-4,5-dihydroxy-2-pyridylalanine, an analog of 3,4-dihydroxyphenylalanine. J Med Chem 10:961-963.

EDWARDS, J.R., Cpt.; E.H. Sanders; and L.R. Sleboda (1971): Methodology investigation of data sample size determination and analysis techniques. U.S. Army Test and Evaluation Command, 214 pages.

BERGER, P.J.; E.H. Sanders; P.D. Gardner; and N.C. Negus (1976): Phenolic plant compounds functioning as reproductive inhibitors in *Microtus montanus*. Science 195:575-577.

SANDERS, E.H.; P.D. Gardner; P.S. Berger; and N.C. Negus (1981): 6-methoxybenzoxazolinone: A plant derivative that stimulates reproduction in *Microtus montanus*. Science 214:67-69.

BERGER, P.J.; N.C.Negus; E.H. Sanders; and P.D. Gardner (1981): Chemical triggering of reproduction in *Microtus montanus*. Science 214:69-70.

GARDNER, P.D.; N.C. Negus; P.J. Negus; and E.H. Sanders (1981): United States Patent Application entitled, "Increasing reproduction in mammalian and avian species," filed 13 July 1981.

SANDERS, E.H. and J.H. Nelson (1982): Determination of epichlorohydrin in potable water. United States Air Force Occupational Environmental Health Laboratory, Report Number OEHL-TR-82-77, 32 pages.

RICK A. BELAN

EDUCATION:

M.S., Hydrology, University of Arizona, Tucson, 1972.

B.S., Geology, Kent State University, Ohio, 1970.

EXPERIENCE:

Staff Hydrogeologist, Radian Corporation, 1980-Present.

Groundwater Hydrologist, William F. Guyton and Associates, 1977-1980.

Captain, United States Army, 1972-1977.

Environmental Impact Assessment Officer, United States Army, 1975.

Research Associate, University of Arizona, 1970-1972.

FIELDS OF EXPERIENCE:

Mr. Belan is presently the hydrogeological project director for an Installation Restoration Program investigating four hazardous waste disposal sites at Hill Air Force Base, Utah. This presently entails the direction of the field investigation efforts for monitor well installation and completion, soil and ground-water sampling, geophysical resistivity surveys and chemical analysis coordination. The results of this effort will be to determine the nature and extent of ground water contamination, if any and remedial actions recommendations.

He worked on three Environmental Protection Agency Superfund projects. These projects entailed the hydrogeological evaluations of hazardous waste sites in Louisiana and New Jersey with the results developing and supporting site remedial measures activities. A third EPA Superfund activity was the evaluation of a new potential waste isolation technology that has been tested. The test attempted to isolate a large block of soil by slurry injection at depth areally and vertically using a patented process. Mr. Belan supervised the site investigation for determining the success of the technique to isolate the soil block. This entailed directing a geophysical survey, and confirmation soil borings to determine the soil isolation success of the test.

He recently coordinated and supervised the air rotary drilling and casing drive completion of a 270 foot monitor well for an unused waste site containing mainly petroleum refinery waste sludges. This upgradient well located in California was drilled in difficult caving formations. The successful completion of this well permitted the location of a third final downgradient monitoring well for the clients.

05/20/83

Rick A. Belan

In the area of solid waste management, Mr. Belan coordinated, supervised, and documented the disposal of fluidized bed combustion byproducts from a synfuels experiment sponsored by the Environmental Protection Agency. This project entailed the coordination with local agencies for the disposal at an appropriate landfill, and hydration of the wastes to neutralize its exothermic reaction prior to disposal.

Mr. Belan was instrumental in providing a hydrogeological assessment of an inactive hazardous waste site in south central New York. The site is listed by EPA as a priority site for action under Superfund. The result of the assessment was the design and costing of a monitoring well program for the client.

As the environmental baseline task leader and geological/hydrogeological team member, Mr. Belan coordinated, developed and identified environmental constraints or issues for a New Mexico Synfuels Project Feasibility Study. Analysis for this study for an industrial client permitted enumeration of ground-water and surface-water environmental issues associated with two in-mine and two plant sites disposal of hazardous/nonhazardous solid waste from a synfuels plant. The results of the study summarized the regional and site-specific geology, ground-water and surface-water. The study identified mine and plant environmental constraint areas concerning solid and liquid waste disposal and also described the waste disposal options as to which mine or plant sites the solid waste should go.

Mr. Belan conducted as part of a geothermal feasibility study a hydrogeological assessment of two aquifers for potential utilization for each of four U.S. military bases which are located in the vicinity of San Antonio, Texas. This entailed the development of conceptual well depths, productivity estimates, static water levels, water temperatures and water quality. These data were used to support benefit/cost analyses of a total geothermal systems package that included costs of well completion and production, heat extraction systems and projected heat demands.

He has completed a state-of-the-art review of geopressured/geothermal fluids disposal technologies and environmental problems associated with the disposal techniques for the Texas Energy and Natural Resources Advisory Council (TENRAC). The two primary disposal methods reviewed were injection wells and surface discharge. From this study, Mr. Belan developed areas of geopressured/geothermal fluids gaps to commercialization. This review and subsequent recommendations provided TENRAC with a means to evaluate Texas geothermal/geopressured development especially towards commercialization and of potential technology areas that merit further study with public funds.

05/20/83

Rick A. Belan

Mr. Belan conducted a preliminary assessment of the feasibility of utilizing a deep injection well for disposal of hazardous waste fluids from a prospective lignite gasification plant in East Texas. This entailed identifying aquifer parameters and computing long-term injection affects in order to assess two candidate aquifers for potential injection horizons.

As a staff hydrogeologist at Radian, Mr. Belan has experience in a wide range of ground-water sampling and analysis efforts. He was the field task leader and hydrogeological analyst for an environmental constraint study of a Lurgi coal gasification plant in East Texas. The study was to be the basis of a solid waste management plan for the plant site and the selection of a solid waste disposal site. It will provide the client with supporting information to be used in obtaining state permits. Mr. Belan is also the task leader for coordinating the air quality, ecology, surface water, and cultural impact portions of the reports, and developing future site-specific environmental studies requirements.

Mr. Belan analyzed aquifer testing methods and parameter data for an in-situ coal gasification project in Wyoming providing regional and vertical characteristics of the coal and overburden aquifers. The results became part of a relicensing application prepared for the U.S. Department of Energy, Laramie, Wyoming.

At refinery waste disposal sites in the area of Kenai, Alaska, Mr. Belan conducted a hydrogeological evaluation. This entailed the field supervision and interpretation of the drilling, geologic sampling, construction, and ground-water sampling of monitor wells in and around the disposal sites. The data obtained was used to define the local ground-water systems, sub-surface geology, and establish if any ground-water contamination had occurred.

Mr. Belan directed and conducted the production and injection testing of two geothermal wells at Navarro College, Corsicana, Texas; one well was to supply geothermal fluid for heat extraction and the other will be used for disposal of the same fluid. He analyzed the test data for well performance, and aquifer parameters; providing a report and recommendations before final geothermal system design.

Mr. Belan, at Radian, conducted an impact assessment of ground-water availability and development quantitatively and qualitatively for a proposed petrochemical complex near the Texas Gulf Coast. His work involved developing a hypothetical well field for producing 6,900 gallons per minute and assessing the ground-water effects with time for varying aquifer conditions. Mr. Belan analyzed the local ground-water qualities to establish present baselines and if sufficient quality plant water could be available for use by the proposed plant.

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He assisted in the preparation of the geology and ground-water hydrology sections of an Environmental Information Document for a proposed lignite mine in East Texas. He worked extensively on the supervision of the drilling, electrical logging, sampling, and construction of the test and monitor wells associated with this program with his former employer and, presently, with Radian prepared the study results for inclusion into the report.

As a ground-water hydrologist with W. F. Guyton and Associates, Mr. Belan provided hydrogeological field support for an overland liquid disposal facility for a client in Louisiana. In order to define the hydrogeology in and around the disposal facility, Mr. Belan provided the field supervision and interpretation of the mud rotary drilling, logging, completion, development, and ground-water sampling of a series of monitor wells. This information aided in defining what impacts, if any, the overland disposal would have on the local ground-water system.

Also while Mr. Belan was working for W. F. Guyton and Associates, his varied field tasks took him to Arizona, Nevada, and Texas. He assisted three large utility power companies in the field supervision of the drilling, geophysical logging, construction, pump and aquifer testing, and water quality sampling of over twenty large production water wells along with a number of observation wells. These wells were drilled on the different jobs by cable tool, mud rotary, and reverse drilling methods. These activities were summarized in well completion reports.

Mr. Belan completed with Mr. Guyton an in-depth analysis of the hydrogeology of the property of Texas Electric Service Company for Texas Utilities Services, Inc. for a prospective water supply, along with a well inventory of property outside the client's area of interest. During this study proposed water well field proposal consisting of 38 production water wells for a projected new electrical generating station. This study included estimated pumping rates, depths of wells, and estimated initial water quality for the well field.

As an officer in the United Stated Army stationed in West Germany in 1975, Mr. Belan initiated, developed and provided Environmental Impact Assessments (EIA) for the U.S. Frankfurt Military Community, and initiated research for 44 U.S. military installations throughout West Germany, which were to be included in the Frankfurt Master Plan. These studies were to define the environmental problems, if any, of the military installations for remedial measures planning and budgeting. His earlier duties included terrain/soils trafficability studies and weather analysis, and the supervision, evaluation, and distribution of tactical information.

As a Graduate Research Assistant in the Department of Soils, Water and Engineering at the University of Arizona, Mr. Belan was responsible for the planning, research, development, and quantifying of Mountain Front Recharge

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Rick A. Belan

of the Tucson Santa Catalina Mountains under the supervision of his thesis director. The results of the study were published in an Arizona Water Resources periodical.

HONORARY AND PROFESSIONAL SOCIETIES:

Sigma Gamma Epsilon Geology Honorary, Technical Division National Water Well Association, Society of Petroleum Engineers.

PUBLICATIONS/REPORTS:

Radian Staff, Technical Review of Reports on Two Hazardous Waste Sites Near Baton Rouge, Louisiana, Austin, Texas, 1982 (Developed report evaluation criteria and reviewed reports on hydrogeological investigation results.)

Ajmera, K. T., W. F. Holland, N. P. Stein, R. A. Belan, and L. J. Holcombe, A Report on Waste Disposal/Hydrology Study New Mexico Synfuels Project, Radian Corporation, Austin, Texas, 1982 (Environmental task leader, document editior, authored activity impacts and hydrogeological sections).

Belan, R. A., J. C. Lippe, and J. P. Rossi, An overview of Regional Geology and Hydrology for Solid Waste Disposal Study, Radian Corporation, Austin, Texas 1982 (Environmental task leader and authored geological and groundwater sections and document editor).

Radian Staff, Volume I Final Report Life Cycle Cost-Effectiveness Studies for Direct Utilization of Geothermal Energy at Four Military Installations in South-Central Texas, Austin, Texas 1982 (Authored hydrogeological parameter development and environmental considerations).

Belan, R. A., K. T. Ajmera, An Overview of Earth Resistivity Surveys - Technical Memorandum, Radian Corporation, Austin, TX, 1982.

Belan, R. A., Technical Note, ETSP Soil Samples for Attenuation Capacity Analysis, Radian Corporation, Austin, TX, 1981.

Belan, R. A. and K. T. Ajmera, Technical Note, ETSP Preliminary Geotechnical and Surface Water SWMP Related Field Studies and Preliminary Layout of Solid Waste Disposal Site, Radian Corporation, Austin, TX, 1981.

Belan, R. A. and A. F. Ferguson, Geothermal Injection and Production Well Test Results: Project Title - Water and Space Heating for a College and Hospital by Utilizing Geothermal Energy, Radian Corporation, Austin, TX, 1981.

Belan, R. A., et al., Summary of the ETSP Solid Waste Disposal Area Selection and Trade-Offs, Radian Corporation, Austin, TX, 1981.

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Rick A. Belan

Belan, R. A., et al., Summary of Findings for the Fatal Flaw Assessment of the Northern Area, Radian Corporation, Austin, TX, 1981.

Belan, R. A. et al., Technical Note, Environmental Constraint Screening of Mine Property and Surrounding Areas for Solid Waste Disposal Siting near Troup, Texas, (Environmental section Task Leader and authored ground-water section), Radian Corporation, Austin, TX, 1981.

Radian Staff, Relicensing Application - Hanna Experimental In-situ Coal Gasification Project, Hanna, Wyoming, (Provided analysis of supplied aquifer parameter values pertaining to regional and vertical distributions and ranges of applicability), Radian Corporation, Austin, TX, 1981.

Radian Staff, Compilation of Environmental Information for a Proposed Olefins Complex, Brazoria County, Texas, (Author of ground-water baseline and development), Austin, TX, 1981.

Radian Staff, Evaluation of Hydrogeology and Waste Management Options at Tesoro Alaska Petroleum Company's Kenai, Alaska Refinery, (Author of hydrogeology section), Austin, TX, 1980.

Guyton, W. F., R. A. Belan, and W. Stevens. Report on the Ground-Water Availability for Prospective Coal-Fueled Electric Generating Station in Ward County, Texas, W. F. Guyton and Associates, Austin, TX.

R. A. Belan authored a number of Environmental Impact Assessments for U. S. Military Installations for the Department of the Army, Federal Republic of Germany.

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ROBERT VANDERVORT

EDUCATION:

M.S., Engineering, University of Washington, 1972.

B.S., Chemical Engineering, University of Washington, 1969.

EXPERIENCE:

Senior Program Manager, Occupational Safety and Health Division, and Petroleum, Shale Oil and Tar Sands Programs, Radian Corporation, 1980-Present.

Group Leader, Industrial Hygiene Services, Radian Corporation, 1979-1980.

Vice-President, DB Associates, Inc. 1976-1978.

Senior Industrial Hygienist, Western Area Laboratory for Occupational Safety and Health, National Institute for Occupational Safety and Health, 1975-1976.

Assistant Director of Program Operations, Division of Technical Services, National Institute for Occupational Safety and Health, 1974-1975.

Assistant Chief, Hazard Evaluation Services Branch, Division of Technical Services, National Institute for Occupational Safety and Health, 1972-1974.

Industrial Hygiene Engineer, Technical Services Branch, Division of Occupational Injury and Disease Control, Bureau of Occupational Safety and Health, 1969-1971.

FIELDS OF EXPERIENCE:

As a Senior Program Manager associated with Radian's Occupational Safety and Health Division Mr. Vandervort is responsible for program management and business development. He serves as primary contact between the client and Radian. He coordinates the input from other Radian divisions on interdisciplinary programs and technically directs major industrial hygiene research studies and service projects. He coordinates the development and marketing of new services and capabilities for occupational safety and health, petroleum, shale oil and tar sand programs. Mr. Vandervort is currently managing: 1) technical sampling and analysis efforts to support product recovery and mitigation of environmental impacts caused by underground leaks of refined petroleum products; 2) environmental, occupational and analytical services to U.S. Air Force bases located in the central and western U.S.; 3) a NIOSH-sponsored control technology assessment of employee exposure controls in the petroleum refining industry; 4) an EPA-IERL study to develop methods for determining overall process control capture effectiveness for

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volatile hydrocarbons used in the coatings industry; 5) design of an environmental and personal exposure monitoring program for the U.S. Navy Public Works Center in San Diego, CA; 6) a NIOSH-sponsored demonstration of workplace exposure controls in the secondary lead smelting industry; 7) task work to assess technical and economic impacts associated with regulatory actions by OSHA; and 8) the technical and engineering aspects of an EPA/OSHA sponsored study to identify economically feasible strategies for the primary and secondary lead industries to comply with EPA and OSHA lead standards.

Mr. Vandervort has also recently provided technical and managerial expertise to these projects: (1) industrial hygiene baseline studies at five U.S. Army DARCOM facilities; (2) biological sampling and analysis for several hundred employees of an electronics manufacturing firm; (3) analysis of potential hazards and development of an employee protection program for a liquid hazardous waste incineration operation; (4) development of health and safety assessments of several proposed coal/lignite conversion projects; and (5) development and presentation of radiation safety training for employees of an in situ uranium leach operation.

As a Group Leader in Radian's Occupational Safety and Health Division, Mr. Vandervort was responsible for the planning and technical direction of industrial hygiene and safety projects. His projects included: (2) Technical direction of and participation in consultative services provided to a major can manufacturer. Services encompassed: (a) workplace air and biologic monitoring for lead; (b) evaluation and analysis of engineering control systems; (c) lead hazard and respiratory protection training; (d) establishment of a comprehensive medical surveillance program; and (e) initiation of new recordkeeping systems. (2) Technical direction of and participation in a control feasibility study of a lead-acid battery manufacturing plant. The study involved identification of all sources of lead emissions into the workplace, analysis of work practices, and recommendation of cost estimates. (3) Design review of a new secondary lead smelting complex from an industrial hygiene standpoint. Activities involved identification of emission sources, specification of control devices, work practices, etc. (4) Study of the fogging characteristics of full-facepiece air-purifying respirators in use at a nuclear waste processing and disposal reservation. (5) Task leader of a Phase I study to assess the potential impact of a new workplace regulation for cadmium. (6) Task leader in a project jointly funded by EPA and OSHA to identify economically feasible control alternatives to attain compliance with the EPA and OSHA lead standards in the primary and secondary smelting industries. (7) Technical director of an EPA/NIOSH project to demonstrate flash agglomeration of flue dust at a U.S. secondary lead-smelter. (8) Preparation of safety information profiles for NIOSH covering lead-acid battery manufacturing, petroleum refinery turnaround, and liquid petroleum project transfer operations. (9) Technical supervision of numerous industrial hygiene sampling and analytical projects to private clients.

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As Vice-President of DB Associates, Inc., Mr. Vandervort was responsible for the planning, direction, and implementation of industrial hygiene/safety and environmental health activities. His projects included the following: (1) Technical direction of a NIOSH-funded control technology assessment of the secondary non-ferrous smelting industry. This study involved air sampling and analysis, work practice observation, and engineering control evaluation. Included in this project was a source test and industrial hygiene evaluation of the Paul Bergsoe and Sons A/S secondary lead smelter in Glostrup, Denmark. (2) Technical direction of industrial hygiene studies of Corps of Engineer project sites in the Omaha District. Studies included walk-through and follow-up surveys, sampling and analysis, and recommendations for hazard control. (3) Key input to the preparation of the OSHA economic impact statement for lead and subsequent participation in public hearings and analysis of the hearing record concerning feasible engineering controls. (4) Preparation of several chapters of a cost estimating manual for use in performing regulatory analyses of OSHA standards. (5) Performance of an industrial hygiene assessment of need study for North Slope oil production and pipeline production factilities. (6) Industrial hygiene studies at EPA's laboratories in Denver, CO which perform pesticide analysis. (7) Participation in the OSHA-NEP foundry consultation program. (8) Technical direction of industrial hygiene studies of refining shale oil using a commercial petroleum refining unit. (9) Development of training materials to OSHA industrial hygienists and compliance safety and health officers. (10) Development and presentation of health and safety training courses for the U.S. Forest Service, the Tennessee Valley Authority, and the National Park Service.

At WALOSH, Mr. Vandervort served as chairman of a technical group responsible for the employee/employer/physician informational aspects of the joint NIOSH-OSHA SCP program to develop occupational safety and health standards to supplement the 1910.1000 air contaminant standards. This work involved comprehensive development and review of information dealing with health hazard characteristics, emergency first aid procedures, respirators, and protective clothing, monitors and measurement procedures, and miscellaneous substance-specific precautions and considerations.

In earlier work at NIOSH, Mr. Vandervort dealt with planning, budgeting, and personnel activities. He assisted in the direction of a division responsible for provision of technical information and assistance, evaluation of health and safety hazards, and consultation services.

HONORARY AND PROFESSIONAL SOCIETIES:

Certified in the Comprehensive Practice of Industrial Hygiene by the American Board of Industrial Hygiene, No. 903.

Certified Safety Professional, Board of Certified Safety Professionals of the Americas, No. 5328.

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Robert Vandervort

Registered Professional Safety Engineer, State of California, No. 1027.

Member of the American Industrial Hygiene Association (National and Local) and the American Academy of Industrial Hygiene.

PUBLICATIONS:

Allcott, G. A., R. Vandervort, J. V. Messick. Practical Considerations for the Protection of Personnel During the Gathering, Transportation, Storage and Analysis of Samples from Hazardous Waste Sites. Proceedings from the National Conference on Management of Uncontrolled Hazardous Waste Sites, October 28-30, 1981. Washington, D.C.

Vandervort, R., and K. Schwitzgebel. Demonstration of Lead Controls at the East Penn Manufacturing Company Secondary Lead Smelter. Proceedings of the USEPA Symposium on Environmental Control in Nonferrous Metals Industries, April 26-30, 1981. (Proceedings in preparation).

Schwitzgebel, K., and R. Vandervort. Emissions and Emission Controls at a Secondary Lead Smelter. U.S. Environmental Protection Agency, IERL. Draft final report, January 9, 1981. (Proceedings in preparation).

Coleman, R. T., Jr., and R. Vandervort. Evaluation of the Paul Bergsoe Agglomeration Furnace and Best Management Practices at a Secondary Lead Smelter. Proceedings of the International Symposium on Lead, Zinc, and Tin 1980. TMS-AIME World Symposium on Metallurgy and Environmental Control. February, 1980.

Coleman, R. T. Jr. and R. Vandervort (principal investigators). Control Technology Assessment - The Secondary Nonferrous Smelting Industry. U.S. Department of Health, Education, and Welfare. DHHS (NIOSH) Publication No. 80-143. October 1980.

Coleman, R. T., Jr., and R. Vandervort (principal investigators). Process and Occupational Safety/Health Catalogue - Secondary Nonferrous Smelting Industry. U.S. Department of Health, Education, and Welfare, NIOSH. July, 1979. NIOSH Contract No. 210-77-0008.

Vandervort, R. Safety Information Profiles: SLI Battery Manufacturing, Petroleum Refinery Turnaround, and Liquid Transfer Operations - Petroleum Products. U.S. Department of Health, Education, and Welfare, NIOSH. April 1979. NIOSH Contract No. 210-78-0130.

Vandervort, R., and K. J. Broadwater. Industrial Hygiene Studies at Corps of Engineer Project Sites. U.S. Army Corps of Engineers, Omaha District. August 19, 1978. Contract No. DACW45-77-C-0113.

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Robert Vandervort

Burton, D. J., R. Vandervort, et al. Standardized Cost Estimating Guidelines to Assist in the Preparation of Regulatory Analyses (RA). U.S. Department of Labor, OSHA. (July 14, 1978) Contract No. J-9-F-6-0227.

Burton, D. J., Vandervort, et al. Technical Feasibility Assessment for the Permanent Lead Standard Based Upon the Hearing Record. U.S. Department of Labor, OSHA. (December, 1977) Contract No. J-9-F-6-0227, Task III.

Vandervort, R. and S. M. Brooks, M. D.: Investigation of Polyvinyl Chloride Film Thermal Decomposition Products and Occupational Illness. I. Environmental Exposures and Toxicology. J. Occup. Med., 19:188-191, 1977.

Brooks, S. M., and R. Vandervort: Investigation of Polyvinyl Chloride Film Thermal Decomposition Products and Occupational Illness. II. Clinical Studies. J. Occup. Med., 19:192-196, 1977.

Burton, D. J., A. A. Adams, R. Vandervort, et al: Technical Feasibility, Cost of Compliance and Economic Impact Assessment of the Proposed Standard for Lead for Selected Industries. U.S. Department of Labor, OSHA, February, 1977. Contract No. J-9-F-6-0227, Task I.

Chapter of Instructors Manual: Occupational Health Training Course, Introduction to Industrial Hygiene, U.S. Department of Labor, OSHA (to be published). Contract No. J-9-F-6-0155.

- o Control of Airborne Hazards and Respiratory Protective Devices: R. Vandervort and D. J. Burton

Chapters of Instructors Manual: Occupational Health Training Course, Health Hazard Recognition, U.S. Department of Labor, OSHA (to be published). Contract No. J-9-F-6-0155.

- o Battery Manufcturing: R. Vandervort
- o Paint Spray and Dip: R. Vandervort and K. Broadwater

Chapters of Instructors Manual: Occupational Health Training Course for Compliance Safety and Health Officers, U.S. Department of Labor. OSHA, December, 1976. Contract No. J-9-F-6-0124.

- o Control of Airborne Hazards: D. J. Burton and R. Vandervort
- o Recognition of Health Hazards: R. Vandervort and D. J. Burton
- o Practical Field Applications: D. J. Burton and R. Vandervort

- Lead	- Mercury
- Carbon Monoxide	- Silica
- Asbestos	- Machine Shop

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Robert Vandervort

- Practical Applications Session, Noise Measurement and Laboratory: R. Vandervort

Vandervort, R., and S. K. Shama, M. D. Isocyanates in Plastics Manufacturing, Transactions of the Thirty-Sixth Annual Meeting of the American Conference of Governmental Industrial Hygienists, Miami Beach, Florida, May 12-17, 1974.

Lowry, L. K., R. Vandervort and P. L. Polakoff, M. D. Biological Indicators of Occupational Exposures to Trichlorethylene. Journal of Occupational Medicine, 16:98-101, 1974.

Primary author of more than twenty detailed industrial hygiene/medical NIOSH Health Hazard Evaluation Determination Reports and other similar evaluation reports.

Vandervort, R., D. B. Hunt, A. V. Simonson, D. J. Burton, and R. T. Hughes. Engineering Improvements and Flue Dust Agglomeration at a Secondary Lead Smelter. American Industrial Hygiene Conference, 1981, Portland, Oregon.

Vandervort, R. and K. Schwitzgebel. Demonstration of Lead Controls at the East Penn Manufacturing Company Secondary Lead Smelter. U.S. Environmental Protection Agency Symposium on Environmental Control in Nonferrous Metals Industries, April 26-30, 1981, San Diego, California.

Vandervort, R., R. T. Coleman, Jr. and D. J. Burton. Health Hazard Control Technology Assessment of the Secondary Non-Ferrous Smelting Industry. NIOSH Symposium on Occupational Health Hazard Control Technology in the Foundry and Secondary Non-ferrous Smelting Industries, December 12, 1979. Chicago, Illinois.

Craig, A. B., Jr., R. T. Coleman, Jr., R. Vandervort and D. J. Burton. Environmental and Occupational Protection in the Secondary Lead Industry. NIOSH Symposium on Occupational Health Hazard Control in the Foundry and Secondary Non-ferrous Smelting Industries, December 12, 1979. Chicago, Illinois.

Burton, D. J., R. Vandervort, J. Hoover and J. A. Gideon. Engineering and Other Exposure Controls Associated with a European Secondary Lead Smelting Blast Furnace. American Industrial Hygiene Conference, 1979. Chicago, Illinois.

Gideon, J. A., R. Vandervort, D. J. Burton, and J. Hoover. Assessment of Control Technology for Non-ferrous Smelters. American Industrial Hygiene Conference, 1979 - Poster Session, Chicago, Illinois.

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Robert Vandervort

Vandervort, R. and S. K. Shama, M. D. Isocyanates in Plastics Manufacturing. American Industrial Hygiene Conference, 1974, Miami, Florida.

Vandervort, R. Practical Air Flow Measurements in the Industrial Environment. Paper presented at the National Bureau of Standards Conference of Flow Measurements as Related to National Needs, February, 1974.

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ANN E. ST.CLAIR

EDUCATION:

M.A., Geological Sciences, The University of Texas at Austin, 1979.

B.A., Geology, Trinity University, 1973.

EXPERIENCE:

Department Head, Radian Corporation, 1982-Present

Group Leader, Radian Corporation, 1979-1982.

Senior Geologist, Radian Corporation, 1980-Present.

Staff Geologist, Radian Corporation, 1978-1980.

Research Scientist Associate, The University of Texas at Austin, Bureau of Economic Geology, 1975-1978.

Research Scientist Assistant, The University of Texas at Austin, Bureau of Economic Geology, 1973-1975.

FIELDS OF EXPERIENCE:

At Radian, Ms. St.Clair has had extensive experience in studies relating to ground-water geology, waste disposal, and environmental impacts. Her work has included acquisition of data on ground water, assessment of water quality impacts, and compilation and interpretation of geologic data including geophysical and core logs, and evaluation of impacts of waste disposal and other activities. In hazardous waste studies her work has also involved evaluation of remedial action alternatives and interface with engineers, chemists and other specialists regarding various aspects of hazardous waste investigations including engineering design and cost of remedial action, control of emissions and odors, and waste characteristics. As Department Head at Radian Ms. St.Clair supervises the work of geologists, hydrologists, and ecologists and has management and technical review responsibility for programs in these technical areas.

Ms. St.Clair is Project Director for the second phase of a continuing study at the McColl hazardous waste site in the Los Angeles area. In this phase, data collected in Radian's Phase 1 field investigation of the site are being evaluated and used in the selection and design of the remedial action plan for the site. The site, which is located adjacent to a residential and recreational area, contains various hydrocarbon wastes, principally acidic refinery sludges and drilling muds. Control of volatile emissions, odors,

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and the potential for contamination of surface water and ground water are being addressed in the remedial action design. The design must meet strict criteria regarding exposure to contaminants both during remedial action implementation and over the long term.

Ms. St.Clair has major responsibility for studies being performed at several uncontrolled hazardous waste sites, including sites identified as priority sites for remedial action under Superfund. She is Project Director for a study to evaluate ground-water conditions at a Superfund site in upstate New York which was used for disposal of wastes from a metal plating operation. The study includes installation of monitor wells and test borings and collection of soil and ground-water samples in order to define the presence or extent of subsurface contamination. Based on the results of the field investigation, recommendations for further study or remedial action will be developed. During the course of this program, Ms. St.Clair has been involved in initial site evaluation and data collection, development of a site field program, and interface with state and federal regulatory agencies.

For the Lipari landfill Superfund site near Pitman, New Jersey, Ms. St.Clair is responsible for coordinating a variety of technical activities as support to EPA Region II. The site contains a variety of industrial wastes, of which several volatile organic chemicals known to be extremely hazardous are of primary concern. Leachate seeps enter surface streams adjacent to the site and have resulted in a ban on fishing and boating in a lake 1000 feet downstream. Ms. St.Clair has overall responsibility for coordinating the following activities at this site — cost-effectiveness evaluation of 32 remedial action alternatives, preparation of an Environmental Information Document assessing the environmental impacts of remedial action alternatives, definition of baseline conditions and design of a long-term monitoring program on the lake, and a treatability study of the landfill leachate. For all these activities Ms. St.Clair is the principal interface with EPA and has primary technical review and management responsibility.

In a study for the EPA Municipal Environmental Research Laboratory, Ms. St. Clair is supervising development of a methodology for conducting evaluations of cost-effectiveness of remedial actions at uncontrolled hazardous waste sites. Under the Comprehensive Environmental Response, Compensation and Liability Act (Superfund), remedial actions conducted at Superfund sites must be demonstrated to be cost-effective. The study involves review of technical and cost data on remedial technologies, evaluation of methodologies for cost-effectiveness and related types of analyis, assessment of impacts of time and discount rates on the evaluation, and development of the analytical framework and guidance manual to be used by decision makers in selecting remedial measures.

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Ann E. St.Clair

Ms. St.Clair has been a key participant in Radian's activities related to collection of insurance underwriting information for Environmental Impairment Liability (EIL) Insurance. She has worked closely with Radian's parent company, Hartford Steam Boiler Inspection and Insurance Company (HSB) in developing procedures for collection of technical and engineering underwriting information and functions in a Quality Assurance role by reviewing results of all Radian investigations of this type. In 1981 Ms. St.Clair was Project Director for a risk assessment of three power plants in the Boston area. The study involved brief site visits and review of corporate and regulatory agency files in order to assess the potential for gradual environmental impairment as a result of plant activities. The study included assessment of ground-water conditions, waste management practices, hazardousness of materials used on-site, population-at-risk, and corporate approach to environmental matters. A report was prepared containing information for use in underwriting Environmental Impairment (EIL) Insurance.

During 1981, Ms. St.Clair was Project Director for a large program to develop a waste management strategy for the Wyoming Coal Gasification Project. The program involved chemical and physical analysis and regulatory classification of power plant and gasification wastes and organic byproducts. Based on the results of the testing, recommendations were made for treatment and disposal of wastes to meet applicable regulatory requirements. In addition, the study included column leaching studies to assess impacts of mine disposal of plant wastes, evaluation of ground water impact of disposal facilities at the plant site, and preparation of applicable state and federal permit applications.

In 1980-81, Ms. St.Clair was Project Director for a program to evaluate waste disposal practices and ground-water conditions at a large petroleum refinery in Kenai, Alaska. The study focused on development of a long-term waste management strategy for disposal of refinery wastes, principally API separator bottoms and crude tank bottoms, which have been designated as hazardous wastes under RCRA. Initially Ms. St.Clair supervised design, installation and sampling of ground-water monitoring wells in the vicinity of existing disposal sites in order to assess the water-quality impacts of past disposal practices. Samples of all refinery waste streams and wastes from existing pits were characterized for the purpose of developing a plan for closure of existing pits and an ultimate waste management plan. Options were evaluated with respect to technical feasibility (particularly in light of climatic factors), environmental acceptability, regulatory compliance, and economics.

In 1979, Ms. St.Clair was Project Director for an investigation of soil/ground-water contamination and remedial action at a pesticide formulation facility in north Texas. The study was aimed at evaluating possible contamination from underground waste storage tanks suspected of leaking. Ms. St. Clair initially conducted sampling of soils in the vicinity of the tanks to

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determine if leakage had occurred. She also designed and supervised installation of a network of ground-water monitoring wells in order to evaluate ground-water flow at the site and to assess water-quality impacts of the suspected leakage. During drilling, core samples were taken in both the unsaturated and saturated zone for chemical analysis. Ms. St.Clair performed slug tests on the wells to provide data on aquifer properties. She also supervised infiltration tests in order to evaluate the surface infiltration conditions and to qualitatively assess the potential for leachate generation. Based upon the results of this study, recommendations were made for further studies and possible remedial actions.

In a study to determine impacts of a product spill at a Solvent Refined Coal-II demonstration plant in Fort Lewis, Washington, Ms. St.Clair was responsible for portions of the ground-water evaluation, including installation of monitoring wells, measurements of water levels, and interpretation of hydrologic and chemical data. She was also involved in interfacing with state regulatory agencies.

Ms. St.Clair was Project Director of a study for EPA Region III, evaluating the suitability of land around the Cheswick Power Station near Pittsburgh, Pennsylvania, for disposal of coal ash and scrubber sludge. The study was conducted as technical support for enforcement actions brought by EPA Region III concerning alleged violations of air emissions regulations from the coal-fired power plant. In the event that installation of SO_2 scrubbers was to be required by EPA, this study was underaken to document the availability of land for disposal of wastes from the scrubbers. During the study, Ms. St. Clair supervised a multidisciplinary team evaluating the hydrogeology, transportation, land use, ecology, and economic factors affecting the acceptability of sites in the vicinity of the plant for disposal of wastes.

In a study for EPA Region VII, Ms. St.Clair supervosed several protrams concerned with suitability of soils for septic tanks and nitrate contamination of ground water in Missouri. Ms. St.Clair supervised technical efforts on three programs. One program involved detailed soils mapping and field examination of septic tank failures in Greene County, Missouri, and in order to develop a septic-tank suitability map. Another study focused on determination of any relationships between water well construction practices and occurrence of ground water contamination in Howell County, Missouri. It involved a field survey for sampling of ground water and for obtaining information on well construction. A third program was conducted to develop a regional map of nitrate concentrations in ground water in the four-state area of EPA Region VII. In addition to development of technical reports for each of these studies, reports were prepared for lay readers.

Ms. St.Clair was Project Director for a feasibility and site selection study for an in-situ gasification project utilizing Texas lignite. The

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study focused on evaluation of environmental factors that might affect project feasibility. Ms. St.Clair was involved in overall project coordination as well as studies related to environmental and hydrologic conditions at several candidate sites.

As a research associate at the Bureau of Economic Geology, Ms. St.Clair was involved in numerous studies requiring collection and interpretation of geologic data, sampling and chemical analysis of ground water, and evaluation of environmental and engineering impacts of man's activities. She was responsible for the preparation of maps, technical reports, and presentations, as a part of these programs.

PROFESSIONAL/TECHNICAL SOCIETIES:

American Institute of Profession Geological Scientists, Certified Professional Geological Scientist 4741; National Water Well Association, Ground Water Technology Division; Geological Society of America; Austin Geological Society.

PUBLICATIONS:

Radian Corporation, "Evaluating Cost-Effectiveness of Remedial Action at Uncontrolled Hazardous Waste Sites," Draft Methodology Manual, January 1983.

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St.Clair, A.E., et al., "Environmental Compliance Review and Risk Assessment for Selected New England Electric System Power Stations," Final Report, December 1981.

Radian Corporation, "Preliminary Conceptual Plan for Solid Waste Management at the Wyoming Coal Gasification Project," submitted to WyCoalGas, Inc., February 1981.

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Radian Corporation. "Results of Waste Analyses and Preliminary Recommendation of a Waste Management Strategy at Tesoro Alaska's Kenai Refinery," December 1980.

St.Clair, A.E., et al., "Evaluation of Hydrogeology and Waste Management Options at Tesoro Petroleum Corporation's Kenai, Alaska Refinery," November 1980.

St.Clair, A.E., et al., "California Heavy Oil Production," Radian Corporation report to the California Energy Commission, November 1980.

St.Clair. A.E., et al., "The Availability of Western Coal for California Use," Final Report to the California Energy Commission, June 1980.

St.Clair, A.E., et al., "Preliminary Fatal Flaw Analysis for Siting a Gasification Plant in Panola County, Texas," May 1980.

St.Clair, A.E., et al., "An Investigation of Potential Soil/Ground-Water Contamination at a Pesticide Formulation Facility in North Texas, Phase II," Draft Report, April 1980.

St.Clair, A.E., and J.L. Parr, "A Preliminary Investigation of Potential Soil/Ground-Water Contamination at a Pesticide Formulation Facility in North Texas." Phase I Final Report, October 1979.

Radian Corporation,"Preliminary Environmental Assessment for a Proposed Olefins Complex, Brazoria County, Texas," August 1979.

Grimshaw, T.W., J.L. Machin, J.R. Mase, A.E. St.Clair, and F.H. Sheffield, "Hydrology Related Regulatory Risks for Lignite Mining at a Prospect in Eastern Texas and Western Louisiana," July 1979.

George, F.M., et al., "Assessment of Gulf Coast Lignite Marketability," Final Report, August 1980.

Garner, L.E., A.E. St.Clair, and T.J. Evans, "Mineral Resources of Texas (map)," Bureau of Economic Geology, University of Texas, Austin, 1979.

St.Clair, A.E., "Mineral Lands in the City of Dallas: Bureau of Economic Geology," University of Texas, Austin, Geological Circular 78-1, 1978.

St.Clair, A.E., T.J. Evans, and L.E. Garner, "Energy Resources of Texas (map)," Bureau of Economic Geology, University of Texas Austin, scale 1:1,000,000, 1976.

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Ann E. St.Clair

St.Clair, A.E., C.V. Proctor, W.L. Fisher, C.W. Kreitler and J.H. McGowen, "Land and Water Resources, Houston-Galveston Area Council," Bureau of Economic Geology, University of Texas, Austin, Land Resources Laboratory Map Series, 25 p., 4 maps, scale 1:125,000, 1975.

02/09/83

WILLIAM M. LITTLE

EDUCATION:

M.S., Civil Engineering, University of California, Berkeley, 1974.

M.S., Hydrology, University of Arizona, Tucson, 1968.

B.S., Hydrology, University of Arizona, Tucson, 1967.

EXPERIENCE:

Senior Engineer and Group Leader, Radian Corporation, 1982-Present.

Senior Engineer, Radian Corporation, Austin, TX, 1978-1982.

Hydrologist, U.S. Army Environmental Hygiene Agency, 1973-1978.

Research and Technical Operations Officer, U.S. Army Engineer Nuclear Cratering Group, 1969-1971.

Graduate Student in Research, University of Arizona, Tucson, 1968.

FIELDS OF EXPERIENCE:

Mr. Little is currently a Senior Engineer and Group Leader with a major technical specialty in ground-water pollution studies. He has served as Project Director and field manager for a large-multidisciplinary characterization of an abandoned hazardous waste disposal site in southern California. The waste materials consist of acid petroleum refinery sludges. Major areas of investigation were: chemical characterization of surface soils, wastes and geologic materials beneath the wastes; quantification of sulfur dioxide and hydrocarbon emissions both from the undisturbed site and from a variety of site disturbances; and determination of the chemical quality of ground water beneath the site. Mr. Little was responsible for managing the field operations and supervising report preparation.

Mr. Little has served as assistant Project Director and field manager for an investigation of the ground-water quality impact of a spill of a coal-distillate liquid at an SRC pilot plant near Tacoma, Washington. The study involved detailed coring to establish the location and extent of unsaturated zone contamination and designing and constructing a series of ground-water monitoring wells to define the extent of ground-water contamination that has occurred. A Remedial Measures Plan was formulated and adopted to remove contaminated materials and to prevent the further spread of ground-water contamination. Following the evaluation of the spill event, Mr. Little directed an expanded program to evaluate the ground-water quality effects of overall plant operations. The possible sources of contamination were

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identified and characterized. Mr. Little then developed a program for ground-water monitoring well construction and supervised the installation of the monitoring network. He designed and conducted aquifer pump tests to define aquifer performance and interpreted the results. A ground-water sampling program has been designed and implemented under his guidance.

Mr. Little has also conducted a program to evaluate the extent of ground-water contamination by refinery operations and wastes at an oil refinery near Duncan, Oklahoma. The initial assessment was based on site reconnaissance, interviews with refinery personnel and a study of existing hydrogeologic and process data.

Mr. Little has recently completed two environmental/regulatory fatal flaw studies for lignite mines and associated power plants in East Texas. He was both Project Director, responsible for overall management and preparation of the final report, and hydrology task leader, responsible for assembling data on hydrologic conditions and assessing probable impacts. He has also recently served as task leader for regulations review, impact analysis and permit application preparation for a commercial-scale coal gasification facility in Wyoming and ground-water hydrology task leader for environmental analysis of a major lignite mine and associated synfuels plant in east Texas.

In another program, Mr. Little directed an evaluation of surface-water and ground-water availability in the vicinity of the proposed Solvent Refined Coal-II (SRC-II) demonstration plant and commercial facilities near Morgantown, West Virginia.

For a private industrial client, Mr. Little reviewed and evaluated the environmental monitoring data from the vicinity of an in situ coal gasification test in the Powder River Basin of Wyoming. The water quality impacts of the test burn were assessed, and a program of aquifer restoration and hydrologic testing recommended. Based on available hydrologic and geochemical data, a conceptual model of the test site was developed. He also developed a ground-water monitoring and contingency aquifer restoration program for a proposed future test. The program includes selection of well locations and parameters for monitoring and specification of restoration strategies.

Mr. Little has also participated in an assessment of the environmental behavior of fluidized bed combustion (FBC) waste for EPA, IERL. Mr. Little was responsible for the design, construction and operation of field cells for testing FBC waste disposal alternatives and for the development of a preliminary waste transport model. He has also been project director and hydrology task leader in the evaluation of the environmental suitability of an ash/scrubber sludge disposal site. He was responsible for the overall management of the program, evaluated the laboratory and hydrogeologic data and predicted contaminant migration.

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William M. Little

As a hydrologist with the Water Quality Engineering Division, U.S. Army Environmental Hygiene Agency, Mr. Little served as a consultant to the Office of the Surgeon General and to major commands and installations on hydrologic aspects of water supply and wastewater disposal. He prepared design criteria for programs of effluent and receiving water monitoring at Army manufacturing and research facilities, evaluated ground-water pollution potential of waste disposal practices, and reviewed draft NPDES discharge permits issued to Army installations. He performed preliminary technical feasibility studies of land treatment of wastewater including field investigations and trial systems design. He conducted environmental impact statement data requirements review and prepared and reviewed portions of environmental impact statements. Mr. Little also managed the Army Medical Department's nationwide Drinking Water Surveillance Program.

With the Corps of Engineers, Mr. Little was assigned as a Research and Technical Operations Officer, U.S. Army Engineer Nuclear Cratering Group. There he conducted a general investigation of hydrologic transport of radionuclides from Plowshare application sites. This work included literature searches, computer simulation, experimental design and conceptual modeling of a transport phenomena. He also participated in final preparation of a 1971 Corps of Engineers report on Wastewater Management in the San Francisco Bay Region.

While at the University of Arizona, Mr. Little was a member of an Operations Research Study Group on the Tucson Basin, gathering background hydrologic material, and conducting a literature and data file search. He directed and participated in preliminary adaptation of a two-dimensional finite difference model of a large, heterogeneous ground-water basin.

HONORARY AND PROFESSIONAL SOCIETIES:

American Geophysical Union, American Water Resources Association, National Water Well Association, Sigma Xi

PUBLICATIONS/REPORTS:

Numerous technical reports in the fields of water resources development, ground-water contaminant migration, occurrence of radionuclides in ground water, land treatment feasibility and receiving water monitoring, including:

Little, W.M., et al., "Environmental Considerations and Air Quality Modeling for the Freestone County Project", Radian Corporation Report to Tenneco Coal Company, March 1982.

Little, W.M., et al., "McColl Site Investigation - Phase 1", Radian Corporation Report to the Participants Committee, November 1982.

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Little, W.M., et al., "Environmental Considerations and Air Quality Modeling for the Edgewood and Mustang Creek Prospects and Associated Energy Park," Radian Corporation Report to Tenneco Coal Company, November 1981.

Little, W.M., et al., "Ground-Water Impact of SRC Pilot Plant Activities Fort Lewis Washington," Radian Corporation report to Gulf Mineral Resources Company, January 1981.

Little, W.M., et al., "Ground Water Modeling at an In-Situ Coal Gasification Test," Radian Corporation Report to confidential industrial client, September 1980.

Little, W.M., and H.J. Williamson, "Recommended Ground-Water Monitoring and Aquifer Restoration Programs, Future In-Situ Coal Gasification Test," Radian Corporation Report to confidential industrial client, September 1980.

Little, W.M., and W.C. Micheletti, "Recommended Aquifer Restoration and Hydrologic Testing Program for an In-Situ Coal Gasification Test," Radian Corporation Report to confidential industrial client, August 1980.

Grimshaw, T.W., and W.M. Little, "Remedial Measures Plan for a Spill of Solvent Refined Coal Liquid at the SRC Pilot Plant, Fort Lewis, Washington," Radian Corporation Report to Gulf Mineral Resources Company, August 1980.

Little, W.M., et al., "Hydrologic Evaluation of a Combined Ash/FGD Sludge Storage Site, Craig Station," Radian Corporation Report to Colorado Ute Electric Association, July 1980.

Grimshaw, T.W., et al., "Generation and Attenuation of Leachate from Fluidized Bed Combustion Solid Wastes," First Year Progress Report, Radian Corporation Report to EPA Industrial Environmental Research Laboratory, EPA-600-7-80-095, May 1980.

Little, W.M., T.J. Wolterink, and M.H. McCloskey, "Water Availability Appraisal for the Proposed Solvent Refined Coal-II Demonstration Plant, Monongalia County, West Virginia," Radian Corporation Report to U.S. Department of Energy, February 1980.

Little, W.M., "Water Quality Geohydrologic Consultation No 24-0286-77," Twin Cities Army Ammunition Plant, New Brighton, MN, 21-23 July 1976, U.S. Army Environmental Hygiene Agency, 11 January 1977 (six additional geohydrologic consultations; sole author on two, senior on three, junior on one).

Little, W.M., Drinking Water Consultation Visit No. 24-1301-77, Joliet Army Ammunition Plant, Illinois, 2-4 August 1976, USAEHA, 9 February 1977 (four additional drinking water consultations).

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William M. Little

Little, W.M., Water Quality Geohydrologic Consultation No. 24-058-75/76, Land Disposal Feasibility Study, Fort Polk, Louisiana, 2-29 April and 9-29 October 1975, USAEHA, 19 August 1976.

Little, W.M., Water Quality Geohydrologic Consultation No. 24-005-76, Land Disposal Feasibility Study, Fort Dix, New Jersey, 21-30 July and 15-23 September 1975, USAEHA, 18 June 1976 (two additional land treatment evaluations as part of water quality engineering special studies).

Little, W.M., Water Quality Monitoring Consultation No. 24-048-74/75, Aberdeen Proving Ground, Maryland, 25-27 February 1974, USAEHA, 17 December 1974 (three additional monitoring consultations).

Little, W.M., Water Quality Engineering Special Study No. 24-017-74, Mixing in Receiving Waters, 7 September-24 October 1973, USAEHA, 3 January 1974.

Little, W.M., Analysis of Hydrologic Transport of Tritium, U.S. Army Engineer Nuclear Cratering Group Technical Memorandum 70-7, Lawrence Radiation Laboratory, Livermore, California, April 1971.

Little, W.M., An Engineering and Economic Feasibility Study for Diversion of Central Arizona Project Waters from Alternate Sites, M.S. Thesis, Department of Hydrology, University of Arizona, Tucson, Arizona, 1968.

12/08/82

JERRY L. PARR

EDUCATION:

B.S., Chemistry, University of Texas at Austin, Austin, TX, 1972.

EXPERIENCE:

Head, Instrumental Analysis Department, Radian Corporation, 1983-Present.

Senior Scientist, Radian Corporation, 1981-Present.

Group Leader, Mass Spectrometry, Radian Corporation, 1979-1982.

Staff Scientist, Radian Corporation, 1976-1981.

Scientist, Radian Corporation, 1974-1976.

Chemist, Texas State Health Department, Austin, TX, 1972-1974.

FIELDS OF EXPERIENCE:

Mr. Parr is currently Head of the Instrumental Analysis Department in Radian's Organic Chemistry Division. In this capacity, he is resopnsible for the direction of the technical staff of this department whose activities include gas chromatography, gas chromatography-mass spectrometry, high pressure liquid chromatography and other related analytical techniques. The department is also responsible for field activities involving sampling of organic species and industrial hygiene activities.

Mr. Parr's current technical interests are in the area of groundwater analysis. He is very active in the development of analytical techniques to measure EPA's hazardous constituents in groundwater and is participating in an ASTM task force which is working in this area.

Earlier, Mr. Parr directed the Austin GC-MS laboratory and the support areas of sample preparation and sample control. He supervised 15 chemists and technicians and was responsible for the scheduling, reporting of data and general supervision for all organic characterizations involving GC-MS analysis at Austin. Mr. Parr is experienced in all phases of environmental organic chemistry including sampling, sample workup, analysis and data evaluation. His responsibilities included the development of new techniques for organic characterizations and project direction in the area of NPDES and RCRA permit activities.

Mr. Parr is currently investigating the use of isotopically labeled compounds as spikes into samples to improve the precision and accuracy of organic analyses. He designed and implemented a study involving field and laboratory spikes to investigate the degradation of organic pollutants

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during transit. He is also serving as task leader for sampling on a large EPA program to develop BAT waste treatment guidelines in the synthetic fuel industry.

For the past five years Mr. Parr has been involved in the area of GC-MS analysis. His responsibilities in this area have included sample analysis, data interpretation, data reporting and method development. These activities have included analysis for the EPA Priority Pollutants, measurement of the organic species in fugitive and point source emissions from oil refineries and the characterization of hazardous organics in aqueous effluents from various industrial processes.

Mr. Parr's experience in the sample preparation area stems from a long-term project conducted during 1975 with DOE investigating the environmental acceptability of the synthetic fuel industry. Many of the techniques currently used at Radian were developed during this program. Since that time, Mr. Parr has remained active in the development of new techniques for the isolation of organics in environmental samples, with current emphasis on toxic waste materials and sediments.

Mr. Parr is active in Radian's field sampling programs and has sampled industrial effluents, groundwater, waste dumps, point source emissions and process streams. Recently, he conducted a program investigating the removal of chlorinated phenols and other pollutants by a proprietary ion exchange water treatment system in Karlstaad, Sweden. He collected and extracted on-site over 40 samples in a ten day period. Previously, Mr. Parr conducted the first field evaluation of EPA's Source Assessment Sampling System (SASS) at two coal-fired power plants. His evaluation of the prototype resulted in substantial changes in the design of the current SASS system.

Initially at Radian, Mr. Parr was involved in the large scale synthesis of a monomer for the Air Force. During this time he conducted laboratory studies for investigating the environmental effects of ponding ash and scrubber sludge from coal-fired power plants.

Prior to joining Radian, Mr. Parr worked for two years at the Texas Department of Health, primarily in environmental analyses for trace metal and conventional wastewater parameters. He also analyzed tissue, blood and urine samples for specific metals such as mercury, lead and arsenic. This experience has enabled Mr. Parr to effectively communicate with the trace element and wastewater laboratories at Radian.

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Jerry L. Parr

PROFESSIONAL/TECHNICAL SOCIETIES:

American Chemical Society

ASTM D34

PUBLICATIONS:

Oldham, R.G., T.I. Strange, K.K DeBower, L.P. Provost, and J.L. Parr, "Automated Analysis of GC-MS Priority Pollutant Data." Abstract ENVT-198, 176th National ACS Meeting, Miami Beach, Florida, September 1978.

Stanko, G.H., R.G. Oldham, R.L. Spraggins, P.H. Lin, and J.L. Parr, "Analysis of Refinery Wastewaters for EPA Priority Pollutants," Abstract ENVT-228 176th National ACS Meeting, Miami Beach, Florida, September 1978.

Oldham, R.G., R.L. Spraggins, P.H. Lin, C.H. Williams, J.L. Parr, "Characterization and Measurement of Organic Emissi:ons from Petroleum Refineries," 71st Annual Meeting, American Institute of Chemical Engineers, Miami Beach, Florida, November 1978.

Oldham, R.G., R.L. Spraggins, J.L.Parr, and K.W. Lee, "Analysis of Organics in Ambient Air", Air Pollution Control Assoc. Conf., Gainesville, Florida, February 13-16, 1979.

REPORTS:

"Evaluation of the Feasibility of Analyzing Groundwater for the Appendix VIII Hazardous Constituents," American Petroleum Institute, May 1983.

"Analysis of Process Wastewaters from the Exxon Donor Solvent Process," Exxon Research and Engineering, April 1982.

"Determination of Priority Pollutants in Produced Water by Isotope Dilution GC-MS and Standard Addition AA," Offshore Operators Committee, February 1982.

"Determination of Organic Species in Domestic Water Exposed to Polybutene Pipe," Shell Development Company, March 1982.

"Interlaboratory Study of EPA Method 624," Shell Development Company, August 1981.

"Quantitative Analysis of Polynuclear Aromatic Hydrocarbons in Liquid Fuels," EPA Contract No. 68-02-2446, November 1979.

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Jerry L. Parr

"Sampling and Analysis of Priority Pollutants from a Swedish Pulp Mill Effluent Treated by Ion Exchange Columns," E.C. Jordan Company, Inc., May 1980.

"Refinery Wastewaters Priority Pollutant Study—Sample Analysis and Evaluation of Data," API Publication 4346, December 1981.

"Analysis of Refinery Wastewaters for the EPA Priority Pollutants," API Publication 4296, May 1978.

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DONALD H. RODGERS

EDUCATION: B.S. Chemistry, Philadelphia College of Pharmacy and Science, 1954. M.S., Chemistry, Villanova University, 1970.

EXPERIENCE: Staff Scientist, Radian Corporation, 1978-Present

Liquid Chromatography Specialist, Tracor, Inc., 1975-1978.

Senior Applications Chemist, Perkin-Elmer Company, 1972-1975.

Group Leader, Wyeth Laboratories, Inc., 1966-1972.

Senior Chemist, Merck, Sharp and Dohme, Inc., 1958-1966.

Analytical Chemist, Mobil Oil Company, Inc., 1954-1958.

FIELDS OF EXPERIENCE:

Mr. Rodgers has 26 years experience in various aspects of chemical analysis, method development, and quality control. This experience has involved mainly gas and liquid chromatography but also includes many other techniques such as infrared and ultraviolet spectroscopy, thermal analysis using the differential scanning calorimeter, flame photometry, potentiometric titrations, nuclear magnetic resonance measurements, thin-layer chromatography, and various wet chemical and colormetric methods. He is Radian's quality control coordinator for all laboratory programs utilizing spectroscopy.

Mr. Rodgers' recent experience at Radian Corporation has primarily been involved with the application of liquid and gas chromatography to problems on various projects. These projects include the isolation and identification of nonvolatile organic materials in drinking water; the analysis, purification and purity determination of various priority pollutants; the isolation and identification of some components of an ophthalmic preparation; and isolation and identification of a substance of botanical origin.

Mr. Rodgers is presently working on a project, in conjunction with Radian's Quality Control Staff, which involves the formulation and recommendation of quality control/assurance procedures to be used with the 600 series methods for priority pollutants.

He has also recently been involved with the analysis of various priority pollutants using the 600 series methods. He was Radian's task leader on two recent collaborative studies for EPA involving the analysis of nitrosamines and benzidines, and is therefore quite familiar with the use and philosophy of the 600 series methods.

In addition, Mr. Rodgers has applied his knowledge of ultraviolet and infrared spectroscopy to various problems involving the quantitative and qualitative analysis of organic materials. He has also applied calorimetry to the determination of purity of standard priority pollutants in connection with an EPA Repository project. He serves as supervisor of the Instrumental Analysis Laboratory including the IR, UV, and DSC instruments.

Prior to joining Radian, Mr. Rodgers worked for Perkin-Elmer Corporation and then Tracor, Inc., as a senior applications chemist and manager of the liquid chromatrography applications laboratories. He made many contributions to the development of modern HPLC, notable of which were the first example of the use of the variable wavelength UV detector at low wavelengths for the detection of olefins, alcohols, esters, and ketones. During this period, Mr. Rodgers made numerous presentations in this country as well as in Europe on the techniques of modern HPLC.

In 1966, Mr. Rodgers joined Wyeth Laboratories, Inc., a pharmaceutical company, as a group leader in the Analytical and Physical Chemistry Sections. At Wyeth, he was responsible for managing the gas chromatography and infrared laboratories. Later, he set up the first liquid chromatography facility at Wyeth. His work also included preformulation studies and investigations related to government regulatory procedures required for IND and NDA applications.

Shortly after joining Merck, Sharp and Dohme in 1958, Mr. Rodgers was promoted from the pharmaceutical control laboratory to the research and development laboratory. In that capacity, he was responsible for developing new analytical methods for the control of experimental pharmaceutical compounds and products. In addition, Mr. Rodgers was involved in setting up a new section which carried out preformulation studies and physical organic measurements on new drug compounds. These studies involved the use of a wide range of instrumental techniques including gas chromatography, differential scanning calorimetry, UV, and infrared spectrophotometry, and miscellaneous wet chemical techniques.

Starting with Mobil Oil Company, immediately after receiving his degree, Mr. Rodgers worked on a variety of problems related to the analysis of petroleum products, cracking catalysts, and oil additives. This work included analysis of trace metals in fuels and catalysts.

PUBLICATIONS;

Rodgers, D.H., "Conductimetric Study of the Interaction of Hexylresorcinol and Amaranth with Quarternary Ammonium Compounds," J. Pharm. Sci., 54, 3, 459 (1965).

Rodgers, D.H., "Separation and Analysis of Psychopharmacologic Drugs by High Efficiency Liquid Chromatography," J. Chromat. Sci., 12, 742 (1974).

Rodgers, D.H., "The Variable Wavelength UV Photometer—A General Detector for Liquid Chromatography," American Lab , February, 1977.

Pape, B., D.H. Rodgers, R.C. Flynn, "The Electrolytic Conductivity Detector as an Element-Select Gas Chromatographic Detector," J. Chromat. , 134 , 1-24 (1977).

Rodgers, D.H. and H.R. Felton, "Design and Performance of a Modular Liquid Chromatographic System," 27th Pittsburgh Conference on Analytical Chemistry, March, 1976.

Felton, H.R. and D.H. Rodgers, "A New Versatile Digital Solvent Programmer," 27th Pittsburgh Conference on Analytical Chemistry, March, 1976.

Rodgers, D.H. and R.C. Hall, "Separation and Response Factors of Selected Pesticide Compounds by HPLC," 28th Pittsburgh Conference on Analytical Chemistry, March, 1977.

Rodgers, D.H., "New Design Concepts in Liquid Chromatography Instrumentation," 29th Pittsburgh Conference on Analytical Chemistry, 1978.

Rodgers, D.H. Developing an Analytical Method by High Efficiency Liquid Chromatography," Perkin-Elmer Publication LC-77 (1974).

Rodgers, D.H., F.C. Kopfler, K.J. Bombaugh and L.D. Ogle, "Study of HPLC Separation and Characterization of Non-Volatile Organics from Drinking Water," presented at 1979 ACS meeting in Washington, D.C., Division of Environmental Chemistry Symposium.

FRED B. BLOOD

EDUCATION:

M.S., Biology (Aquatic Ecology), Virginia Commonwealth University, 1973.

B.S., General Science (Biology and Chemistry), Virginia Polytechnic Institute, 1969.

EXPERIENCE:

Biologist, Radian Corporation, 1981-Present.

Senior Consultant, Seagull Environmental Control, 1980-1981.

Technical Field Advisor, U.S. EPA Region V, Law Engineering Contract, 1979.

Aquatic Ecologist, Law Engineering Testing Co., 1976-1979.

Staff Biologist, Virginia Electric and Power Co., 1973-1976.

Visiting Scholar, Smithsonian Institute, 1973.

Teaching Assistant, Virginia Commonwealth University, 1971-1973.

Teacher, Henrico County (Virginia) Public Schools, 1969-1971.

FIELDS OF EXPERIENCE:

At Radian, Mr. Blood is responsible for managing the collection, identification, and interpretation of ecological data. His particular area of expertise involves aquatic ecology and environmental toxicology. The following project experience demonstrates his expertise.

Mr. Blood is Project Director on a subcontract for the Cummins Creek lignite project. Collection of aquatic ecological data, including analyses of fish, and plankton data is required. The study has been recently expanded to include 20 stations including rivers, streams, cattle tanks, and SCS reservoirs.

As a task director, Mr. Blood was responsible for evaluating an urban lake below an uncontrolled hazardous waste site (U.S. EPA Superfund Site). This project involves the collection of biotic, water, and sediment samples. Extensive organic and metal analyses have been accomplished to document existing conditions and derive a monitoring program for the future. A cost-effective monitoring program based on empirical data and environmental fate modeling was proposed.

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Fred B. Blood

Mr. Blood was Project Director of a study concerning six uranium mine reclamation ponds in Southeast Texas. This study involves the quantification of physico-chemical data, periphyton, fish, macrophytes, phytoplankton, zooplankton, and aquatic macrophytes. Also included are limited chemical analyses of the water column and detailed trace metal and radionuclide determinations of water, sediments, and various aquatic biotic food chains. The evaluation included insights into the relative success and failure of reclamation processes.

As an Ecology Task Leader, Mr. Blood was responsible for input into an environmental assessment for a lignite gasification plant located in Northeast Texas. This study includes all the standard terrestrial and aquatic studies including wetlands, vegetative mapping, wildlife, and aquatic environments.

Mr. Blood has also been involved with environmental studies associated with a synfuels plant on the Ohio River Floodplain in Kentucky. Responsibilities included analyses of endangered and protected species, wetlands, fisheries, macroinvertebrates, and plankton. A NEPA-responsive study was accomplished. He also provided input into three other lignite projects, either at an ecological resources or aquatic resources level. These inputs were primarily concerned with "fatal flaw" or other siting programs.

While with Radian, Mr. Blood has provided asbestos inspection services to a large State hospital in Ohio, air monitoring consultation to the City of Austin, Texas, and helped with the training of laborers. This last process provided the attendees of the Northern California Laborers Training Center with official certification by CAL-OSHA as asbestos workers and started a process where the State may require more stringent respiratory protection of asbestos workers. Mr. Blood has also participated in writing/reviewing specifications, air monitoring, and quality control for several asbestos removal contracts.

As Senior Consultant for the Seagull Environmental Company, Mr. Blood had a variety of responsibilities. Many buildings and structures were inspected and evaluated by Mr. Blood, including work for various school districts, universities, and private industry. Mr. Blood made presentations on asbestos-related problems at seminars and meetings sponsored by state and local environmental health associations in Ohio and Illinois. He oversaw the training of asbestos workers at numerous projects in states ranging from Illinois and Florida to New Hampshire.

Mr. Blood served as Technical Field Advisor to the U.S. EPA asbestos-in-schools program for Region V (Chicago). In this capacity he made over 60 presentations to 2,500 people across the six-state region. He inspected and evaluated more than 100 schools and provided advice to numerous contractors and analytical laboratories in becoming involved in asbestos abatement activities.

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Fred B. Blood

As an Aquatic Biologist with Law Engineering Testing Company, Mr. Blood was Project Director for a baseline aquatic survey for a paper mill in the Oconee River, near Dublin, Georgia. The study included physico-chemical data, fisheries, periphyton, and macrobenthos collected at seven stations during four seasons.

Mr. Blood was co-director for a water quality management study for the Corps of Engineers. The study involved two one-year studies of two reservoirs (Carters Lake and Lake Allatoona) in Georgia. These studies involved twice seasonal collections at over 15 stations on both reservoirs. Data collected included: physico-chemical profiles, nutrients, trace metals, and organic pesticides in the water column; fisheries; macrobenthos; zooplankton; periphyton; Hester-Dendy substrates; algal growth potential; and trace metal and organic pollutants in various portions of the aquatic food chain.

As a biologist for Virginia Electric and Power Company, Mr. Blood was responsible for biological analyses of aquatic environments associated with nine operational sites and two site screening studies. The operation studies included six estuarine and three freshwater sites. Mr. Blood studied thermal and velocity discharge effects on macroinvertebrate and fish communities. He also evaluated impingement and entrainment. Two sites, one estuarine and one freshwater, included nuclear power stations and Mr. Blood supervised collections for radionuclide studies.

In the summer and fall following graduate school, Mr. Blood was co-holder of a visiting scholar fellowship to study the freshwater clams (Unionidae) of Virginia. He also attended a biological field camp sponsored by the University of Montana on Flathead Lake, Montana. While in Montana, he studied trophic states in two pot-hole lakes, snow algae, and physical geology.

As a graduate student, Mr. Blood was involved in various studies, including: intensive catfish culture, primary productivity (conventional and as C^{14}); fishery surveys, acid mine drainage, post-impoundment surveys, and his thesis on freshwater clams.

While teaching general, earth, and biological sciences to eighth and ninth graders, Mr. Blood participated in summer research projects. These studies involved pre-impoundment surveys for a large recreational reservoir to be utilized by a nuclear power plant and acid-mine recovery studies.

HONORARY AND PROFESSIONAL SOCIETIES:

Society of Environmental Toxicology and Chemistry; American Fisheries Society; Ecological Society of America; Sport Fishing Institute.

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Fred B. Blood

PUBLICATIONS:

"Environmental Assessment of the Remedial Action Alternatives for the McColl Site," Fullerton, CA (Radian Report, 1983).

"Reclamation Impoundment Study: An Analysis of Aquatic Habitats Created in the Reclamation of Uranium Surface Mines in South Central Texas," (Radian Report, 1983).

"Development of a Monitoring Program to Evaluate the Effect of Remedial Actions at the Lipari Landfill on Alcyon Lake, Pitman, New Jersey," (Radian Report, 1983).

Ecology - in "Environmental Consideration and Air Quality Modeling for the Edgewood and Mustang Creek Prospects and Associated Energy Park," (Radian Report), 1981.

Aquatic Resources Chapter - in "Preliminary Environmental Analysis Report for Coal Gasification Plant, Henderson, Kentucky," (Radian Report), 1981.

"Oconee River Biological Baseline Evaluation," (Law Engineering Report), 1980.

"Contract Report - A Water Quality Management Study of Carters Lake, GA," (Law Engineering Report), 1980.

"Contract Report - A Water Quality Management Study of Lake Allatoona, GA," (Law Engineering Report), 1980.

"A 316(b) Study of the Lansing Smith Steam Plant," prepared for Gulf Power Company (Law Engineering Report).

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PROFESSIONAL PRESENTATIONS:

"Investigation of Nutrient Factors Limiting Phytoplankton Productivity in Two Central Virginia Ponds" (with J. Reed, G. Samsel, and H. Winfrey), Annual Meeting, Association of Southeastern Biologists, Mobile, AL, 1972.

08/24/83

Fred B. Blood

"Preliminary Comparison of Two Oxidation Ponds with Different Trophic States in Central Virginia," (with J. Reed, G. Samsel, and H. Winfrey), Annual Meeting, Association of Southeastern Biologists, Mobile, AL, 1972.

"Unionidae (Mollusca) of the Pamunkey River, Virginia" (with M. Riddick and J. Reed), Annual Meeting, Association of Southeastern Biologists, Savannah, GA, 1974.

"An Effects Assessment of Impingement at the Lansing Smith Steam Plant" (with R.A. Garrett), Annual Meeting, Association of Southeastern Biologists, Tuscaloosa, AL, 1978.

"Strategies of Collecting Macro-invertebrates," Annual Meeting, Georgia Fisheries Workers Association, Rome, GA, 1978.

"Asbestos in Schools, Its Evaluation, Its Solutions," 65 locations throughout six states (MI, IL, OH, IN, MN, WI), 1979.

08/24/83

Biographical Data

Howard P. Ross

Senior Geophysicist and Project Manager

PII Redacted [redacted]

Education

B.A. in Geology, 1957, University of New Hampshire
M.Sc. in Geophysics, 1963, Pennsylvania State University
Ph.D. in Geophysics, 1965, Pennsylvania State University

Professional Affiliations

Society of Exploration Geophysicists
American Geophysical Union
European Assn. Exploration Geophysicists
American Assn. Petroleum Geologists

Experience Record

1958-1960 Computer and Acting Chief Computer, United Geophysical Corporation, Pasadena, California. Computer for reflection seismic crew engaged in oil and gas exploration; interpreted and processed seismic records; also organized office work, drafting, accounting.

1961-1965 Graduate Research Assistant, The Pennsylvania State University, Mineral Conservation Section, University Park, Pennsylvania. Planned, executed and interpreted geophysical field surveys conducted each summer to determine if diabase or massive magnetite gives rise to various magnetic anomalies.

1965-1967 Research General Physical Scientist, Air Force Cambridge Research Laboratories, Lunar-Planetary Research Branch, Bedford, Massachusetts. Organized and conducted laboratory reflection spectroscopy experiments and telescopic observations of the moon in the 0.2 to 3.0 micron (UV-VIS-IR) region of the spectrum. Pursued theoretical studies of the moon and planets. Developed instrumentation and monitored contracts for their fabrication. Programmed in Fortran IV for the reduction of spectroscopic data, signal-to-noise studies, mathematical models of geologic processes. NASA co-investigator Apollo Application Program (pre ERTS).

1967-1969 Senior Research Geophysicist, Kennecott Exploration, Inc., Geophysics Division R&D, Salt Lake City, Utah. Conducted research in aeromagnetic interpretation, field rock

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magnetization studies. Developed first generation computer programs for magnetic interpretation schemes. Programmed electromagnetic coupling problem for IP studies. In-company consultant for remote sensing programs. Detailed and reconnaissance aeromagnetic interpretation. Supervised interpretation of deep-sea magnetic data (manganese nodule research).

1969-1977	Senior Geophysicist, Bear Creek Mining Company/Kennecott Exploration, Inc., Geophysics Division, Salt Lake City, Utah. Designed, supervised, conducted and interpreted geophysical field surveys in search of porphyry copper and other mineralization-induced polarization, magnetic, and gravity methods. Developed interpretation programs for magnetic data, and magnetic properties studies. Supervised contract aeromagnetic surveys and the geologic interpretation of these data. Presented seminars on the use and interpretation of geophysical data. In-company consultant on remote sensing (SLR and other imagery programs). Group Leader, Interdisciplinary Research Program for skarn research, September 1971 - March 1972. Field experience and interpretative work in New Mexico, Arizona, Nevada, Wisconsin, Minnesota, Montana, Utah and Tennessee.
1977-date	Section Head, Geophysics; Senior Geophysicist and Project Manager, Earth Science Laboratory, University of Utah Research Institute, Salt Lake City, Utah. Principal investigator for geophysical survey planning, supervision, and interpretation contracts. Coordinate, interpret, and evaluate geophysical surveys and geologic data to form technical case histories of geothermal exploration/reservoir assessment studies. Provide management assistance and technical evaluation as necessary to Department of Energy. Supervise and conduct geophysical interpretations for industry clients, U.S.G.S., and UN contracts.
1979-date	Consultant, DOE/Richland, Washington and Rockwell Hanford Operations. Member Geologic Overview Committee for Basalt Waste Isolation Project.
1979-date	Consultant, Office of Nuclear Waste Isolation (ONWI), Battelle Memorial Institute, Columbus, Ohio. Member of the Geologic Review Group for site characterization studies of the national nuclear waste storage program.
1980-date	Consultant in Exploration Geophysics. Clients include: Thermal Power Co., San Francisco, CA Exxon Minerals Co., Tucson, AZ Dept. of Energy/Nevada Operations, Las Vegas, NV Kennecott Exploration, Inc., Casper, WY

Publications

"In Situ Determination of the Remanent Magnetic Vector of Two-Dimensional Tabular Bodies," Ross, H. P. and Lavin, P. M., Geophysics, 31, No. 5, 949-962 (1966).

"A Bidirectional Reflectance Accessory for Spectroscopic Measurements," Hunt, G. R. and Ross, H. P., Applied Optics, 6, No. 10, 1687-1690 (1967).

"A Simplified Mathematical Model for Lunar Crater Erosion," Jour. Geophysical Research, 73, No. 4, 1343-1354 (1968).

"A Statistical Analysis of the Reflectance of Igneous Rocks from 0.2 to 2.65 Microns," Ross, H. P., Adler, J. E. M. and Hunt, G. R., Icarus, 11, 46-54 (1969).

"Recognition of the Geologic Framework of Porphyry Copper Deposits on ERTS-1 Imagery," Allan, J. W., Andrews, R. K., Ross, H. P. and Wilson, J. C., Kennecott Expl. Inc., Final Report to NASA, September (1975).

"Interpretation of Resistivity and Induced Polarization Profiles, Calico Hills and Yucca Mountain Areas, Nevada Test Site," Ross, H. P. and Lundbeck, J., University of Utah Research Institute, Earth Science Laboratory, Rept. No. 8, to the U.S. Geological Survey, September (1978).

"Numerical Modeling and Interpretation of Dipole-Dipole Resistivity Data, Lakes District, Ethiopia," Ross, H. P., Smith, Christian and Atwood, J. W., University of Utah Research Institute, Earth Science Laboratory, Rept. No. 15, to the United Nations, December (1978).

"Numerical Modeling and Interpretation of Dipole-Dipole Resistivity Data, Olkaria Field, Kenya," Ross, H. P., Smith, Christian, Glenn, W. E., Atwood, J. W. and Whipple, R. W., University of Utah Research Institute, Earth Science Laboratory, Rept. No. 16, to the United Nations, February (1979).

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"Interpretation of Resistivity and Induced Polarization Profiles With Severe Topographic Effects, Yucca Mountain Area, Nevada Test Site," Smith, Christian and Ross, H. P., University of Utah Research Institute, Earth Science Laboratory, Rept. No. 21, to the U.S. Geologic Survey, October (1979).

"Numerical Modeling and Interpretation of Dipole-Dipole Resistivity and IP Profiles, Cove Fort-Sulphurdale KGRA, Utah, Ross, H. P., UURI/ESL Report, DOE/DGE Contract No. DE-AC07-78ET28392 (1979).

"A Summary of the Geology and Geophysics of the San Emidio KGRA, Washoe County, Nevada, Mackelprang, C. E., Moore, J. N., and Ross, H. P., Geothermal Resources Council Trans., v. 4, p. 221-224 (1980).

"Review of Well Logging in the Basin and Range Known Geothermal Resource Areas, Glenn, W. E., Ross, H. P., and Atwood, J. W., paper SPE 9496, 55th annual meeting, SPE/AIME, Dallas, 16 p. (1980).

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"Review of Well Logging in the Basin and Range Known Geothermal Resource Areas", Glenn, W. E., Ross, H. P., and Atwood, J. W., Jour. Petroleum Tech., May, p. 1104-1118 (1982).

"A Study of Well Logs from Cove Fort-Sulphurdale KGRA, Millard and Beaver Counties, Utah", Glenn, W. E., and Ross, H. P., UURI/ESL Report No. ESL-75, 39 p. (1982).

Patent

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"The Roosevelt Hot Springs, Utah Geothermal Resource - An Integrated Case Study," Ross, H. P., Nielson, D. L., Glenn, W. E., Moore, J. N., Smith, Christian and Christensen, O. D., 66th Annual AAPG Meeting, San Francisco, June (1981).

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"The Cove Fort-Sulphurdale KGRA - A Geological and Geophysical Case Study (abs.)," Ross, H. P., Moore, J. N. and Glenn, W. E., Geophysics, 46, No. 3 (1981).

"An Examination of 2-D Earth Model Resolution With the Dipole-Dipole Resistivity Method (abs.)," Smith, Christian, Glenn, W. E., Tripp, A. C. and Ross, H. P., Geophysics, 46, No. 3 (1981).

"A Strategy of Exploration for High Temperature Hydrothermal Systems in the Basin and Range Province," Ward, S. H., Ross, H. P. and Nielson, D. L., 65th Annual AAPG meeting, Denver, June (1981).

"Review of Well Logging in the Basin and Range Known Geothermal Resource Areas," Glenn, W. E., Ross, H. P. and Atwood, J. W., Paper SPE 9496, 55th Annual Meeting, SPE/AIME, Dallas, 16 p. (1980).

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"An Integrated Magnetic Study of Intrusive and Altered Sedimentary Rock of the Santa Rita, New Mexico Porphyry Copper Deposit," Trans. AIME, Dallas, February (1974).

Biographical Data

Claron E. Mackelprang

Geophysicist

PII Redacted [redacted]

Education

Assoc. Sc. in 1959, Civil Engineering, College of Southern Utah
B.Sc. in Physical Geology, 1963, Utah State University
Selected graduate level courses

Professional Affiliations

Member of Society of Exploration Geophysicists

Awards

Recipient of Best Paper Award, Site-specific Exploration Session, Geothermal Resource Council Annual Meeting, 1980.

Experience Record

1962-1963 Geological Field Assistant, Bear Creek Mining Company. Aided senior geologist in geochemical sampling and field mapping of selected areas within San Juan Mountains of Colorado, also in Utah and New Mexico.

1964-1977 Assistant Geophysicist, Bear Creek Mining Company/Kennecott Exploration Inc. Applied extensive knowledge of geophysical techniques to prophyry copper and molybdenum, massive sulphide, base metal, phosphate and sulphur exploration in domestic and foreign environments. Responsible for geophysical survey design, field crew supervision, data acquisition, and data interpretation utilizing advanced computer techniques, maintenance of gravity data library. Conducted and supervised ground EM, magnetic and induced polarization surveys in Haiti, utilizing local, inexperienced labor resulting in delineation of volcanogenic massive sulfide mineralization. Supervised gravity, ground magnetic and induced polarization crews, including data acquisition and interpretation in Alaska, Washington, Idaho, Montana, Nevada, Utah, New Mexico, Colorado, Arizona, Texas, Tennessee, Wisconsin and Minnesota. Developed programs to process gravity, altimeter, transit and stadia data on Hewlett-Packard 9830 system; devised procedures for processing geophysical field data on hand-held programmable calculators enabling gross data interpretation while still in the field.

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1977-1979	Geophysicist, Bear Creek Mining Company. Responsible for supervision and coordination of geophysical personnel, survey design, implementation and data interpretation from the application of geophysical techniques supporting geologic exploration staff, resulting in major contribution to discovery of blind copper deposit. Designed, implemented and compiled, and interpreted aeromagnetic surveys utilizing small, in-house aeromagnetic system designed for light aircraft. Conducted rock and soil geochemical surveys with emphasis on precious metal environments of Mexico and western U.S. resulting in delineation of prospective zones. Compiled land status maps from courthouse records identifying mineral and surface ownership. Performed public relations work with property owners obtaining trespass permission for geophysical crews. Prepared final interpretations of geophysical survey data submitting reports to District Exploration managers.
1979-date	Geophysicist, Earth Science Laboratory, University of Utah Research Institute, Salt Lake City. Utah. Coordinate, interpret and evaluate geophysical survey data to form technical case histories of geothermal exploration/reservoir assessment studies. Provide geophysical expertise and assistance to private industry and state agencies working with DOE/DGE Industry Coupled Program. Provide geophysical expertise to private industry as member of a consulting team evaluating geophysical data for occurrences of oil, mineral deposits and geothermal fluids.

Publications

Interpretation of the Dipole-Dipole Electrical Resistivity Survey, Tuscarora Geothermal Area, Elko County, Nevada, ESL Rept. #72, February 1982.

Two-Dimensional modeling Results of Telluric-Magnetotelluric Data from the Tuscarora Area, Elko County, Nevada, ESL Rept. #63, January 1982.

Interpretation of a Dipole-Dipole Electrical Resistivity Survey, Colado Geothermal Area, Pershing County, nevada. ESL Rept. #41, Sept. 1980.

Numerous properietary reports for Bear Creek Mining Company/Kennecott Exploration Inc. regarding interpretation of geophysical data.

Papers

"A Summary of the Geology and Geophysics of the San Emidio KGRA, Washoe County Nevada", GRC, 1980.

"Interpretation of a Telluric-Magnetotelluric Survey at the Tuscarora Geothermal Exploration Unit, Elko County, Nevada", SEG, 1981.

APPENDIX I: MONTHLY PROGRESS REPORTS

October 1982 through July 1983

(pp. I-1 through I-37)

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October 1982 through July 1983

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I-2

During the month of October, technical progress was made with respect to the following specific project functions.

SAFETY

Informal discussions concerning the development of the safety plan were held by UBTL with Lt. Col. Moody, Mr. Ron Rich and Mr. Del Thomas. The latter two gentlemen were from the Hill AFB Safety Group. A detailed safety plan for each aspect of the survey was prepared and submitted to Lt. Col. Moody at Hill AFB for review.

DATA REVIEW

The data review has begun. The Hill AFB office of the Bioengineer has been the primary contact and source of information to date. Based upon initial data review, project specific information gaps have been identified and information requested through the Bioengineer. Items reviewed have been installation reports, maps, figures and aerial photographs of the waste disposal areas.

GEOPHYSICS

The ESL Division of UURI coordinated with Radian Corporation on the order of sites for the resistivity surveys.

A detailed on-site investigation of the work areas was completed, noting grounded structures (power lines, pipelines, buildings, fences), paved areas and topographic features, all of which affect the resistivity survey. Using this information, the geophysicists have developed a preliminary survey design for each of the four survey areas.

Survey work began at Chemical Waste Disposal Site 3 and two 30 foot "a" spacing dipole-dipole resistivity profiles were completed. The data show a highly variable resistivity distribution and well defined resistivity low associated with the disposal pit. Low resistivity layers at a depth of 30 to 45 feet probably indicate a layer of higher clay and moisture content. The data have been numerically modeled to provide this interpretation. Two more lines need to be completed here.

SOIL CORING/ANALYSIS

A total of 11 reconnaissance soil samples were taken from Berman Pond, and Chemical Disposal Pits 1, 2, and 3 for chemical analysis. These samples were used to aid in determining actual soil coring field conditions, visual evidence of waste and/or contaminated soil, and to aid in tailoring the field safety program. The soil sampling was conducted by representatives of Radian and UBTL.

The soil samples were taken from about five feet at Berman Pond to one foot at the other areas. Hand augering was found to be very difficult due to large numbers of cobbles and pebbles that would plug or block the auger bit at Berman Pond and Chemical Disposal Pits 1 and 2. The augering at Chemical Disposal Pit 3 was somewhat easier to cut but sample retrieval was difficult as the soil encountered was a sticky silt-clay material. Waste material was visually evident at Chemical Disposal Pits 1 and 2 as well as some odor; while at Chemical Disposal Pit 3, the main evidence of contamination was odor.

INSTALLATION OF WELLS AND LYSIMETERS

The well drilling program, contract and general specifications coordination has been accomplished with Construction Drilling International (CDI), Salt Lake City. Drilling has been arranged to begin during the second week in November.

The lysimeter program has not been implemented yet. It will be finalized after the data review, soil coring and resistivity surveys have been accomplished.

WATER SAMPLING/ANALYSIS (FIRST EPISODE)

No activity.

WATER SAMPLING/ANALYSIS (SECOND EPISODE)

No activity.

DATA INTERPRETATION/FINAL REPORT

Aerial stereo photographs of the waste areas of Hill AFB (1971) were analyzed to aid in locating the disposal areas. Chemical Disposal Pits 1 and 2 were readily identified and preliminary location and size measurements were made. Chemical Disposal Pit 3 was not as readily identifiable but the general location was inferred. Preliminary size and location measurements were made and used to spot the reconnaissance soil borings.

Top of clay data from the 1980 series monitor wells associated with Landfills 3 and 4 were obtained from the Hill AFB Bioengineer and used to update information from a 1976 study. Evaluation of the composite data has helped to fill data gaps and adjust the planned monitor well program.

Preliminary outlines for the interim report and the final report were developed.

PLAN/ADMINISTRATIVE

On October 15, 1982, a conference telephone call was held between Dr. Sim Lessley (UBTL/UURI), Dr. Howard Ross (ESL/UURI) and Mr. Rick Belan (Radian Corporation) for the purpose of planning the initiation of the survey.

On October 27, 1982, a meeting was held at UBTL between Dr. Sim Lessley, Dr. Howard Ross, Mr. Rick Belan and Mr. Claron Mackleprang (ESL/UURI). Project status was discussed, administrative matters were covered and activities were planned.

Representatives of UURI and Radian Corporation met with Mr. Keith Davis and Lt. Col. Moody of the Hill AFB Bioengineering Group for coordinating survey activities, information requests and briefing on the disposal areas. A place for storage of field equipment was coordinated.

Base access for project personnel was requested by letter. Personnel and vehicle badges were secured.

During the month of November, technical progress was made with respect to the following specific project functions.

SAFETY

Construction Drilling International personnel were provided a safety briefing prior to the commencement of the Hill AFB monitor well construction activities.

DATA REVIEW

Periodic data reviews continued during this month. Additional sources of data have been coordinated and/or obtained from the Hill AFB Civil Engineer, U.S. Army Corps of Engineers, U.S. Geological Survey and, retired and active Hill AFB personnel. The data provided continue to allow refinement of the field program particularly as to the locations and types of monitor wells. Items screened have been base utilities records, regional reports, and aerial photographs of the waste disposal areas.

GEOPHYSICS

A total of five resistivity lines, one 7-electrode spread each, were completed at Chemical Pit No. 3. The numerical modeling and interpretation of the data are nearly complete.

The electrical resistivity survey of Berman Pond is in progress. Three long lines of three 7-electrode spreads each have been completed. Interpretation of the field data is just beginning.

SOIL CORING/ANALYSIS

A total of 45 soil samples were taken from Chemical Disposal Pits 1, 2, and 3, six monitor wells and one background soil location for chemical analysis. The samples from the Disposal Pits were used to further define the waste bodies and contamination potential. The sampling locations were selected based upon the 11 reconnaissance samplings done in October and preliminary resistivity survey results on Chemical Disposal Pit 3. Distinct waste material was encountered at Chemical Disposal Pits 1, 2,

and 3. A larger hand auger bit was used, which made the augering easier than it was with the smaller bit used in October.

An additional soil sampling method was selected to aid in determining if lateral and/or vertical contamination about the disposal sites has occurred. The method involves collection of a composite soil sample discharged from the drilling rig during the drilling of monitor wells. This will also aid in determining if the drill cuttings, caught on plastic sheeting, are hazardous and in need of special disposal. Two soil samples have been collected from 6 of 7 monitor wells completed. The first sample as practical is taken at an interval below ground level but above estimated ground water level. The second sample is collected around ground water level to the underlying clay. The results of the chemical analysis can be compared vertically and laterally for contamination.

The eleven reconnaisance soil samples taken in October have been analyzed for all parameters except TOX (Total Organic Halogens) and the results relayed to the Radian field geologist. Problems have been encountered with the analysis for TOX in the soil from Hill AFB. The resolution of the problem will be described in the December Report.

INSTALLATION OF WELLS AND LYSIMETERS

Construction Drilling International (CDI) of Salt Lake City, Utah began the drilling and construction of the Hill AFB monitor wells on November 10, 1982. Seven monitor wells have been constructed around Landfill 3 and Chemical Disposal Pits 1 and 2. They are M-1, M-2, M-4, M-6, M-7, M-9, and M-10. (Refer to Figure 3-1 on page 10 of the Preliminary Survey Report for well locations.) The lysimeter program has not yet begun. It will be conducted in December.

Monitor Well Materials Change

Two monitor wells (M-7 and M-9) were completed using plastic casing instead of the proposed stainless steel screen. During the drilling the underlying clay was encountered at a much shallower level than anticipated based upon previous study data. There was no direct evidence of ground

water. Rather than use an expensive well screen in a potentially dry hole, this more economical approach was used, saving the stainless steel screens for more appropriate applications.

Deep Monitor Well Depth Change

Two of the proposed deep monitor wells at Landfill 3 have been completed at a depth of about 40 feet (M-6 and M-10). The proposal indicated a depth of about 150 feet until ground water below the clay was encountered. In both wells a distinct clay was penetrated into some productive fine sand and silts. The wells were completed in these productive zones resulting in the needed hydrogeological information and reduction of construction costs for these wells.

Change in Number of Monitor Wells

Based upon data review and constructed monitor wells, an additional monitor well to be completed in the vicinity of the golf course has been recommended. The purpose is to establish whether the ground water system extends from the Landfill 3 area under the golf course and if it does, to determine the nature of the aquifer system. The budget presently permits the construction of this well. This recommendation has been presented to the Project Officer and to the Hill AFB bioengineer. No objections were noted.

WATER SAMPLING/ANALYSIS (FIRST EPISODE)

No activity.

WATER SAMPLING/ANALYSIS (SECOND EPISODE)

No activity.

DATA INTERPRETATION/FINAL REPORT

Well records from the "1980" series and "W" series wells have been reviewed and interpreted for correlation with the current well drilling activities.

No work on the final report was performed in November.

PLAN/ADMINISTRATIVE

On November 5, 1982, Mr. Rick Belan of Radian Corporation provided an informal project update to Lt. Col. Moody (Hill AFB) and to Maj. Capell (Wright Patterson AFB).

On November 24, 1982, individuals from UBTL/UURI, ESL/UURI and Radian Corporation presented an informal briefing at Hill AFB. Personnel from the offices of the bioengineer and the civil engineer were present. The overall project status and recommendations were presented and discussed.

During the month of December 1982, technical progress was made with respect to the following specific project functions.

SAFETY

No additional activities were conducted.

DATA REVIEW

Data were obtained during the month that provided additional information pertinent to this study. The data were obtained from the Hill AFB Bioenvironmental and Civil Engineers, U.S. Army Corps of Engineers, and the University of Utah Research Institute (UURI). The data permitted refinement of the field program as to the location and types of monitor wells. Items screened were photographs of activities at Berman Pond, a geothermal exploration report and geophysical logs, an interpretive sketch of geology in the vicinity of Chemical Disposal Pit No. 3, and foundation logs from sites near Berman Pond.

GEOPHYSICS

Activities during December are summarized as follows:

1. Resistivity measurements were initiated and completed at Chemical Disposal Pits No. 1 and 2.
2. Resistivity measurements were initiated and completed at Landfill No. 3 and at the golf course.
3. Resistivity measurements were completed at Berman Pond.
4. Numerical modeling and interpretation of the data continued for Chemical Disposal Pit No. 3.
5. All field data have been reduced and apparent resistivity pseudosections have been plotted.
6. The leased resistivity equipment was returned and the leases terminated.

Chemical Disposal Pits No. 1 and 2, Landfill No. 3 and Golf Course Resistivity Surveys

Four lines of two 7-electrode spreads each were completed at Chemical Disposal Pits No. 1 and 2. A clay layer appears to be present at varying depths beneath the disposal area. Numerical modeling of the data has begun. A single 7-electrode spread was completed near base production well No. 4 as an extension of this work.

Five north-south lines were completed across Landfill No. 3 and an additional double spread at the golf course. Low apparent resistivities indicate a thick clay layer beneath much of the landfill, with higher resistivities indicating thick sands to the south of the landfill.

A limited resistivity survey was conducted at the golf course. Its purpose was to geologically "fill in the gap" between the well and a bluff 1300 feet to the north. The data will aid in determining the geologic or hydrologic continuity, if any, between the golf course and the study sites.

A limited resistivity survey was conducted on the west side of the study area and south of Chemical Disposal Pits No. 1 and 2 and Landfill No. 3. Its purpose was to supplement the limited data available concerning the continuity of the subsurface clay in order to assess any westw.rd migration of contaminated groundwater.

Berman Pond Resistivity Survey

Two additional 7-electrode spreads were completed at Berman Pond and the data were reduced and plotted on pseudosections. High resistivities throughout these data suggest that no continuous clay layer is present within the depth probed by the resistivity survey.

Chemical Disposal Pit No. 3 Resistivity Survey

The resistivity survey results indicate that Chemical Disposal Pit No. 3 is located in a very complex geological area. This information plus previous field observations indicate that additional subsurface data need to be acquired before making a final determination regarding the installation of a monitor well.

SOIL CORING/ANALYSIS

A total of 24 soil samples were taken from Chemical Disposal Pits No. 1, 2 and 3 and from Berman Pond. The samples taken during monitor well drilling are being held for potential chemical analysis. The other soil samples were submitted for analysis.

Analytical results for 32 soil samples were reported in December in addition to the TOX results for the first 11 reconnaisance samples.

For the determination of total organic halogens (TOX) in soil, modification of an existing EPA method for the determinatin of TOX in water was proposed. EPA Method 8.56 has been adapted for the determination of TOX in soil. Some difficulties were encountered while implementing the modification. These were resolved with assistance from the manufacturer of the instrument (O.I. Corp.) and from EPA personnel.

INSTALLATION OF WELLS AND LYSIMETERS

Construction Drilling International (CDI) completed the drilling and construction of four (4) monitor wells for a total of 11 completed to date. The monitor wells were completed in the areas of Chemical Disposal Pits 1 and 2, Berman Pond and the Hill AFB golf course.

A total of six (6) lysimeters have been installed about Berman Pond (4) and Chemical Disposal Pit No. 3 (2). These were emplaced using hand and hollow stem augering. Hollow stem augering and split spoon sampling was provided by Earth Exploration and Drilling of Bountiful, Utah (12-10-82).

Monitor Well Materials Change

Two monitor wells (M-6 and M-10) were completed with 5 feet of stainless steel screen as proposed. During the drilling through the underlying clay to ascertain its thickness, it was difficult to determine when the clay ended. The driller (CDI) noted that it drilled as a clay to total depth and the clay cuttings observed had some sand, silts and some groundwater. No distinct groundwater zones were encountered. After

making static water level measurements and soundings, the screens were set across the sandy zones estimated to be at the bottom of the clay. Bailing development of monitor wells M-6 and M-10 indicated the formation to have an apparent low productivity.

When monitor well M-3 was drilled, similar conditions were found. Therefore, plastic casing and gravel pack were used to complete the well with 20 feet of slotted perforations. This was done to insure that the well would be completed across productive zones for groundwater development and sampling.

Monitor Well Construction Delays

Snow storms and extremely cold field conditions have caused delays in the drilling program. Of approximately 24 potential drilling days, 11 days were called due to weather (7) and/or related construction problems (4).

Golf Course Well

A monitor well was installed at the Hill AFB golf course. Data gained from drilling and sampling will help clarify the nature of the aquifer system underlying Landfills No. 3 and 4 and Chemical Disposal Pits No. 1 and 2.

Monitor Well at Chemical Disposal Pit No. 3

Based upon the preliminary resistivity survey results at Chemical Disposal Pit No. 3 and field observations, it was recommended that additional subsurface data be obtained. The data will be used to make a final assessment of the depth and location of a monitor well or the need for one. Earth Exploration and Drilling of Bountiful, Utah, will provide hollow stem auger drilling about January 6 and 7, 1983, to determine the geology at Chemical Disposal Pit No. 3. It is planned that approximately 4 holes will be augered to a depth of about 40-50 feet and if any groundwater is encountered, a 2-inch piezometer will be completed in the auger hole. The piezometer will permit static water level measurements and water sampling.

WATER SAMPLING AND ANALYSIS (FIRST EPISODE)

Six monitor wells were sampled during December. They were: M-1, M-2, M-4, M-7 and M-9 which were constructed for this survey as well as W-8 which was constructed in 1976 near Landfill No. 3. Due to low productivity of the wells, the withdrawal volume prior to sampling has been reduced from 5 to 3 well volumes as necessary.

Monitor Well Sampling

All of the monitor wells constructed under this program which were bailed this month were found to be very low producers, therefore, minimal development is expected. As necessary in the future, 3 well volumes will be withdrawn before water sampling for chemical analysis rather than the previously proposed 5 volumes. This is proposed because the monitor wells drew down very quickly to the bottom and slowly recovered, thus insuring that surrounding formation water was entering the well.

Golf Course Well

Sampling the golf course well and selected wells in the area of Landfill No. 3 for the determination of a panel of water quality parameters was recommended. This recommendation will be considered after the results of the field and laboratory conductivity measurements have been reviewed.

Conductivity Analysis

The conductivity of all water samples will be determined in the laboratory as well as in the field.

WATER SAMPLING AND ANALYSIS (SECOND EPISODE)

No activity.

DATA INTERPRETATION AND FINAL REPORT

Some data interpretation was conducted in support of monitor well construction.

No work on the final report was performed in December.

PLAN/ADMINISTRATIVE

Field activities were suspended during the holidays. They are scheduled to resume the first week in January.

During the month of January 1983, technical progress was made with respect to the following specific project functions.

SAFETY

Personnel from two organizations were field briefed on the use of minimal safety apparel during their assistance to this project. The first were the two drillers from Earth Exploration and Drilling, Bountiful, Utah. They assisted the investigation with hollow stem augering at Chemical Disposal Pit No. 3. During the augering, solvent odors were encountered in two auger holes. After initially encountering odors, the drillers were instructed in the use of rubber boots and gloves. These were used as added protection for handling the drill rig equipment and soil that may be contaminated as well as during rig, clothing, and equipment wash down.

The Base Bioengineer provided personnel to assist in lysimeter sampling. They were field instructed during the course of a sampling effort in safety considerations for sampling lysimeters. Protective equipment included rubber gloves and eye wear to guard against lysimeter splashing.

Auger hole cuttings that were obviously contaminated were shoveled as practical into plastic bags to minimize new ground contamination at piezometers P-6 and P-7 associated with Chemical Disposal Pit No. 3.

DATA REVIEW

Additional data pertinent to this study were obtained from UURI, UBTL, Utah Geological Association and Hill AFB personnel. The data aided in supporting the conclusion that Chemical Disposal Pit No. 3 is situated on a very complex site. Items reviewed included two reports and geological features of the study area, an extract on landslide forms, a report on the soils of Utah, and discussions of old wells in the vicinity of Landfills No. 3 and 4.

GEOPHYSICS

Activities during January are summarized as follows:

1. Numerical modeling of electrical resistivity data obtained during October, November and December 1982
2. Ground magnetic profiles at Berman Pond
3. Ground magnetic profiles at Chemical Pits No. 1 and 2 and Landfill No. 3.
4. Self-potential surveys at Chemical Pits No. 1 and 2.

Chemical Disposal Pits No. 1 and 2 and Landfill No. 3

Numerical modeling of electrical resistivity data was initiated and completed for selected profiles.

Six ground magnetic profiles totaling approximately 509 stations were completed in the Landfill No. 3, Chemical Pits No. 1 and 2 area. The data are being compiled at present. They seem to identify major areas of landfill. Further interpretation is needed.

Self-potential (SP) surveys were initiated at Chemical Pits No. 1 and 2, but have not yet been completed. SP anomalies appear to be associated with Chemical Pits No. 1 and 2, but more data and interpretation are required.

Berman Pond

Numerical modeling of electrical resistivity data was initiated and completed for selected profiles.

Seven ground magnetic profiles totaling approximately 690 stations were completed at Berman Pond. Anomalies exceeding 200 gammas were recorded, and it appears that the ground magnetic data, when fully compiled and interpreted, will delineate much of the landfill area at Berman Pond. The success of the ground magnetic method here can be attributed to steel and iron in concrete fill and other trash.

Chemical Disposal Pit No. 3

Numerical modeling was completed for resistivity data at Chemical Pit No. 3. These survey data have been modeled in great detail because of the apparent structural complexity of the disposal area and the importance of understanding the migration paths for the solvents dumped here. Borings have substantiated the complex subsurface.

SOIL CORING/ANALYSIS

A total of 15 soil samples were taken from Chemical Disposal Pit No. 3 for potential chemical analysis. These were taken using a split spoon sampler during investigative hollow stem augering at the site.

Results of the analysis of 15 soil samples from Berman Pond were reported.

INSTALLATION OF WELLS AND LYSIMETERS

Construction Drilling International has completed all 11 monitor well surface protective features (i.e., protective posts, surface grout and security caps). The remaining items to complete as inventoried by Radian are general site policing and returning four stainless steel screens not used during present well construction.

Ten shallow piezometers have been emplaced at Chemical Disposal Pit No. 3. These 2-inch PVC piezometers were emplaced using solid and/or hollow stem augers provided by Earth Exploration and Drilling of Bountiful, Utah. These were emplaced not only to provide ground water level information but also provide ground water sampling locations.

The first five piezometers were emplaced (6-13 January) based upon recommendations made in December in order to define the site geologically. The lithology and depths to ground water greatly changed over small distances (i.e., tens of feet) in this case over an area of about 160 by 180 feet. This indicated that the site was more complex than originally thought.

Therefore, a meeting was held between UBTL/UURI, Radian and ESL/UURI to discuss the hollow stem augering results. It was recommended that an additional set of piezometers be installed to further define the site. Approval was obtained and a second set of piezometers was installed beginning on 25 January through the end of the month.

The second set of piezometers again confirmed the complexity of the site, both geologically and hydrologically. Two piezometers yielded (P-6 and P-7) ground water with strong "solvent" odors not encountered during the first set of piezometers. The total area now covered by all 10 piezometers is about 330 feet by 160 feet. Depths to ground water below ground level range from 10 to 25 feet and the piezometer zones of completion are either in clays or sand/gravel materials.

Piezometer installation problems were encountered during both phases. These were due to water sands collapsing the hold and/or sticking the bit, clay slowing the augering and piezometer casing breaking off below ground level. All problems were overcome without adversely affecting completion times or budget.

WATER SAMPLING AND ANALYSIS (FIRST PHASE)

A total of 13 monitor wells were sampled during the month. This includes two earlier monitor wells constructed before this field investigation in the vicinity of Landfill No. 3. Four of six lysimeters completed at Berman Pond and Chemical Disposal Pit No. 3 have been sampled. Two lysimeters, and almost a third, have been completely sampled this month. A new lysimeter was emplaced at Chemical Disposal Pit No. 3 for potential sampling in the vicinity of Piezometer P-5 where previous augering indicated moisture at the completed depth. The 10 piezometers which have been completed at Chemical Disposal Pit No. 3 are undergoing development for sampling in February.

Chemical analyses for most of 16 water samples were completed in January.

Lysimeter Sampling

During lysimeter sampling, it was found that due to the small volumes produced, it was necessary to pull samples over a period of days. In some cases, this required compositing samples in order to obtain the minimum required volumes for analysis. Personnel from the Base Bioengineer assisted in the task after field instruction by Radian and receiving UBTL sampling priority instructions.

Problems encountered with the lysimeters include: maintaining suction (three lysimeters), freezing (one lysimeter), and very little moisture capture (two lysimeters). Attempts have been and are being made to correct the problems. The frozen lysimeter will be sampled during spring when the ground is not frozen.

Piezometer Development

The 10 completed piezometers at Chemical Disposal Pit No. 3 are undergoing bailing development and close groundwater level monitoring to observe the effects of bailing on the piezometers. All of the piezometers to date are very low producers. Two piezometers (P-7, P-6) were completed in zones with solvent odors, all other completed piezometers did not have any obvious signs of contaminations. The piezometers will be sampled in early February.

WATER SAMPLING AND ANALYSIS (SECOND EPISODE)

No activity.

DATA INTERPRETATION AND FINAL REPORT

Preliminary field analysis at Chemical Disposal Site No. 3 indicates that piezometer P-7 may have been completed in waste fluids that are outside of the present known disposal site. This is evidenced by its position appearing to be hydraulically upgradient of the disposal pits. Chemical analysis and surveying of the piezometers will aid in confirming or refuting this observation.

Chemical Disposal Pit No. 3 field analysis of static water levels indicates a general eastward movement. Final directions cannot be assessed until after chemical analysis and surveying have been analyzed.

PLAN/ADMINISTRATIVE

A meeting was held between UBTL/UURI, Radian and ESL/UURI on 17 January 1983, to discuss the initial augering results at Chemical Disposal Pit No. 3. The augering results confirmed the resistivity survey indications that the site was geologically complex. It was therefore recommended that additional soil boring be conducted to further define the site, and that a 6-inch monitor well at this stage would not be appropriate.

During the month of February 1983, technical progress was made with respect to the following specific project functions.

SAFETY

No additional activity.

DATA REVIEW

No additional activity.

GEOPHYSICS

Acitivities during February are summarized as follows:

1. Numerical modeling of electrical resistivity data obtained during October, November and December 1982.
2. Compilation of ground magnetic data taken over Berman Pond, Chemical Disposal Pits No. 1 and 2 and Landfill No. 3.
3. Completion and compilation of Self-Potential (SP) surveys at Chemical Disposal Pits No. 1 and 2 and Chemical Disposal Pit No. 3.

Numerical modeling was completed for all five lines of resistivity data at Chemical Disposal Pit No. 3 because of the complexity of the disposal area. Two lines were modeled at Berman Pond. Four lines were modeled at Chemical Disposal Pits No. 1 and 2. Three lines were modeled at Landfill No. 3. In addition, the line located near Base Well No. 4 was also modeled. Underlying clay layers are clearly present in all areas except Berman Pond. This does not inply total absence of a clay layer at Berman Pond. It only implies that a clay layer, if present, has to be deeper than the 60 to 90-foot sounding capability of the 30-foot dipole spacing used on the resistivity lines.

The Self-Potential data obtained at Chemical Disposal Pits No. 1 and 2 were supplemented with fill-in lines. These data are most encouraging in that SP anomalies are clearly associated with the disposal area.

The Self-Potential data obtained at Chemical Pit No. 3 are fairly nondescript. No major anomalies appear to be associated with any chemicals in the disposal area. An area has been defined, however, where it is thought waters leaving the general slump area are moving downslope.

SOIL CORING/ANALYSIS

The soil samples collected during the installation of the ten piezometers at Chemical Disposal Pit No. 3 were received in the laboratory for analysis. The analyses were completed.

INSTALLATION OF WELLS AND LYSIMETERS

All wells and selected ground locations about the waste sites were inventoried, identified, and flagged in preparation for elevation and/or location surveying. The surveying is to be conducted by Hill AFB survey crews. Well data gathered included present well and water depths, in situ groundwater temperature and conductivity measurements. These data will aid in defining the hydrogeological system(s) in the vicinity of the waste sites, particularly Landfill No. 3 and Chemical Disposal Pits No. 1 and 2, which have the greatest number of old and new monitor wells.

WATER SAMPLING/ANALYSIS (First Episode)

The ten piezometers completed at Chemical Disposal Pit No. 3 were sampled for chemical analysis. The laboratory encountered difficulty with equipment in analyzing the previous groundwater samples for purgeable aromatics (EPA Method 602). Therefore, 13 wells were resampled for this analysis. The chemical analyses were completed. Base Well No. 4 was sampled for the analysis of organic priority pollutants by GC/MS.

WATER SAMPLING/ANALYSIS (Second Episode)

No activity.

DATA INTERPRETATION/FINAL REPORT

Field data and notes have been formulated and interpreted to develop the tables for the interim Data Review. The Data Review is to provide the following information:

1. Sketch maps of locations of monitor wells, lysimeters and auger samples.
2. A summary of raw geological data.
3. A summary of the chemical analyses of samples taken during the first sampling episode.
4. Recommendations for the second sampling episode.

PLAN/ADMINISTRATIVE

Coordination has been conducted to request Hill AFB surveying assistance in providing topographic elevation control off base in the vicinity of Chemical Disposal Pit No. 3. This will prospectively aid in the definition and interpretation of the slump feature(s) situated at the site.

The hydrogeological project director, Mr. Rick Belan, had to depart the field several weeks early due to an emergency. Final field tasks were implemented by Mr. Gordon Alcott, who has been assisting in the field investigations.

Base building key, personal and vehicle passes for Mr. Belan have been returned. In addition, the Radian monitor well keys are presently distributed as follows: Hill AFB Bioengineer (6), UBTL (1), and Construction Drilling International (1).

The base weather office has been initially contacted for obtaining base weather data for the study.

Requests for modification of the contract were submitted. The modifications involved a change in the number of proposed analyses. A copy of the revised Summary of Chemical Analyses is attached.

Summary of Chemical Analyses Proposed for the Hill AFB, Utah Phase II Survey (Revised February 16, 1983)

No. of Samples	Type of Samples	Type of Analyses
60	Water	Total Organic Carbon (TOC)
60	Water	Total Organic Halogens (TOX)
37	Water	Oil and Grease
33	Water	Phenol
17	Water	Methyl Blue Active Substances (MBAS)
22	Water	Total Dissolved Solids (TDS)
52	Water	Cyanide
22	Water	Sulfate
17	Water	Arsenic
52	Water	Beryllium
52	Water	Cadmium
52	Water	Chromium
17	Water	Copper
22	Water	Iron
17	Water	Lead
22	Water	Manganese
17	Water	Mercury
60	Water	Purgeable Halocarbons
37	Water	Purgeable Aromatics
7	Water	GC/MS Screen (EPA Methods 624 and 625 with up to 10 unknowns identified for each method per sample)
7	Water	ICP Screen (37 elements)
50	Water	pH (field measurement)
50	Water	Specific Conductance (field measurement)
48	Water	Specific Conductance (laboratory measurement)
50	Water	Temperature (field measurement)
25	Water	Three metals by AA (metals to be identified)
25	Water	Two analyses by GC (compounds to be identified)
14	Water	Calcium
14	Water	Magnesium
14	Water	Sodium
14	Water	Potassium
14	Water	Carbonate
14	Water	Bicarbonate
14	Water	Chloride
14	Water	Fluoride
14	Water	Nitrate
14	Water	Hardness
14	Water	Silica
78	Soil	Total Organic Carbon (TOC)
78	Soil	Total Organic Halogens (TOX)
50	Soil	Oil and Grease

48	Soil	Phenol
57	Soil	Cyanide
57	Soil	Beryllium
66	Soil	Cadmium
66	Soil	Chromium
132	Soil	Moisture

During the month of March 1983, technical progress was made with respect to the following specific project functions.

SAFETY

No additional activity.

DATA REVIEW

No additional activity.

GEOPHYSICS

No additional field activities were conducted. The remaining data were reduced and a draft report of the geophysical work was prepared by the Earth Science Laboratory.

SOIL CORING/ANALYSIS

No additional activity.

INSTALLATION OF WELLS AND LYSIMETERS

No additional activity.

WATER SAMPLING/ANALYSIS (FIRST EPISODE)

The GC/MS analyses of water samples were completed.

WATER SAMPLING/ANALYSIS (Second Episode)

The second round of sampling is scheduled to occur in late April and/or early May. The exact sampling period will depend upon the weather, preferably after spring thawing and precipitation event(s).

DATA INTERPRETATION/FINAL REPORTS

The Earth Science Laboratory prepared a draft report of the geophysics work for review by UBTL and Radian Corp. The interim Data Review was submitted on 14 March 1983. Selected parameters are being

examined principally for areal distribution as well as ground water classification at the Chemical Disposal Pits 1 and 2, Landfill 3 and Golf Course areas.

PLAN/ADMINISTRATIVE

The second round of ground water sampling has been coordinated between UBTL and Radian Corp. The content of the final report has been discussed. Some adjustments to the modification requested in February, 1983 were made. Surveying assistance and weather office information were coordinated with Hill AFB personnel.

During the month of April 1983, technical progress was made with respect to the following specific project functions.

SAFETY

No additional activity.

DATA REVIEW

No additional activity.

GEOPHYSICS

No additional activity.

SOIL CORING/ANALYSIS

No additional activity.

INSTALLATION OF WELLS AND LYSIMETERS

No additional activity.

WATER SAMPLING/ANALYSIS (First Episode)

There was a problem with the anion/cation balance on the water sample from monitor well M-7 at Landfill No. 3. The laboratory data were reviewed and no errors were discovered. The sample has been maintained in storage for reanalysis with the samples from the second round of sampling.

WATER SAMPLING/ANALYSIS (Second Episode)

Recommendations from Radian Corp. and the USAF in response to the Interim Data Review were incorporated into the sampling and analysis program. Field sampling and analytical activities were coordinated for the second round of sampling. Sampling began the last week of April. It is expected to be completed the second week of May.

DATA INTERPRETATION/FINAL REPORTS

The requested weather data summary has been received from Hill AFB for report analysis. The final report base figures have been coordinated for drafting. The aerial photography and field data analysis of Chemical Disposal Pits Nos. 1 & 2 (locations and dimensions) have been finalized for the final report. The collection of data on health effects, concentration standards and the environmental fate of selected analytical parameters detected in groundwater about the waste sites has begun. Graphical representations of boring logs were constructed and correlated to the geophysical cross-sections at Chemical Disposal Pit No. 3. Due to the extreme complexity of the site vertically and areally, data were difficult to interpret.

PLAN/ADMINISTRATIVE

The surveying requirements for the monitor wells and control points have been finalized and coordinated with the Hill AFB Civil Engineers for all of the investigated waste sites. Additionally, the topographic survey at Chemical Disposal Pit No. 3 has been coordinated. The elevation and location survey is projected to be completed about mid-May.

A recommended format for the Final Report was received from the Project Officer for review. The completion of Draft Final Report is projected for July 11, 1983.

During the month of May 1983, technical progress was made with respect to the following specific project functions.

SAFETY

No additional activity.

DATA REVIEW

No additional activity.

GEOPHYSICS

No additional activity.

SOIL CORING/ANALYSIS

No additional activity.

INSTALLATION OF WELLS AND LYSIMETERS

No additional activity.

WATER SAMPLING/ANALYSIS (First Episode)

No additional activity.

WATER SAMPLING/ANALYSIS (Second Episode)

The second round of monitor well sampling and measurement activities was completed during the second week of May. Two additional monitor wells and a surface runoff point were sampled (as coordinated with the Project Officer). These monitor wells, W-13 and 80-19, are located about midway between the Landfill No. 3 upgradient wells M-6 and M-7 and the Golf Course Well GC-1. The surface sampling point is a golf course parking lot storm drain that leads into monitor wells W-13 and 80-19 area. These sampling points will aid in correlating ground water recharge, if any, from the Golf Course area to the Landfill No. 3 and Chemical Disposal Pits Nos. 1 and 2 areas. Chemical analyses for these additional samples were the major anions and cations.

High levels of contamination and instrumental difficulties slowed the analysis of the purgeable halocarbon samples (EPA Method 601) and the purgeable hydrocarbon samples (EPA Method 602). The Project Officer agreed to the suggestion of an extension of time for the analysis of the purgeable hydrocarbon samples.

DATA INTERPRETATION/FINAL REPORTS

The field data taken during the second round of sampling has been received for evaluation. These data will now permit the majority of the final hydrogeological data analysis to be conducted, as well as incorporated with the final chemical analyses and survey-weather delays and the monitor well survey data is projected to be finished about the first week in June. Finalization of the 3 1/2 months of daily field activity logs for the final report is ongoing. Selected tables and figures are being drafted for the 69 piezometers, monitor and base wells at Hill AFB to develop the hydrogeology at the five waste sites under investigation. These tables and figures concern changes between sampling episodes of static water levels, in-situ temperature, conductivity, and oil slick measurements. The oil slick measurement at Chemical Disposal Pits No. 1 and 2 indicated about a one foot thickness increase at Monitor Well W-4 from the last measurement in November 1982. Therefore, an additional set of measurements will be conducted at the Chemical Disposal Pit Nos. 1 and 2 area the third week in May. The static water level changes for all the sites ranged from about one-half foot to about six feet, except for Berman Pond where Monitor Well BPM-1 appears to have a decrease change of about two feet. The Berman Pond Wells BPM 1 and 2 will be measured again about the third week in May to cross-reference measurements. The Golf Course parking lots have been analyzed for their precipitation runoff potential to the Landfill 3 and Chemical Disposal Pits 1 and 2 areas. Berman Pond waste volume was estimated, and correlation of the first round of analytical data was conducted.

PLAN/ADMINISTRATIVE

The surveying requested for the monitor wells and control points are being conducted by the Hill AFB Civil Engineer's survey crew. Due to weather delays the completed survey data is expected to be available about the first week in June.

The table of contents for the Final Report was coordinated with the Project Officer.

The four remaining monitor well steel screens have been taken to the Hill AFB Bioengineer by Construction Drilling International (CDI) for storage. CDI has also completed monitor well site cleanup after their activities.

During the month of June 1983, technical progress was made with respect to the following specific project functions.

SAFETY

No additional activity.

DATA REVIEW

No additional activity.

GEOPHYSICS

No additional activity.

SOIL CORING/ANALYSIS

No additional activity.

INSTALLATION OF WELLS AND LYSIMETERS

No additional acitivity

WATER SAMPLING/ANALYSIS (First Episode)

No additional activity.

WATER SAMPLING ANALYSIS (Second Episode)

The chemical analyses associated with the second episode of sampling were completed. The data were tabulated in a format suitable for inclusion in the final report.

DATA INTERPRETATION/FINAL REPORTS

Most of the hydrogeological base data maps have been drafted for Chemical Disposal Pits No. 1 and 2, Landfill No. 3, Berman Pond and Chemical Disposal Pit No. 3. The maps will be completed after receiving final survey "tie in" data from the Hill AFB Civil Engineer's Office.

The "oil slick" monitoring data results at Chemical Disposal Pits No. 1 and 2 indicate that the magnitude of groundwater rise and oil thickness increase is much greater than originally expected due to the exceptional winter precipitation. Therefore, an extended water level and oil thickness measurement program has been recommended to the Air Force.

The due date for the draft final report was extended to August 31, 1983, to accommodate the inclusion of the new water level data and the "tie in" survey data in the final report.

PLAN/ADMINISTRATIVE

The surveying data requested for the monitor wells has been received from the Hill AFB Civil Engineer's Office. Coordination was conducted with the Base Civil Engineer's Office for survey grid "tie in" data, cross-check of selected survey data and several monitor well control points. Final survey data is expected in early July.

The Hill AFB "W" series well logs that may have been stored at Brooks AFB were requested from the Project Officer. These logs of the Landfill 3, 4, and Chemical Disposal Pits No. 1 and 2 areas would have provided accurate geologic data for incorporation into the hydrogeologic map data base for this present study. Dr. Sanders indicated that the logs were not available.

Additional groundwater level and oil slick thickness measurements in the area of Chemical Disposal Pits No. 1 and 2 were performed by personnel from the Hill AFB Bioengineer's Office at the request of the project team.

During the month of July 1983, technical progress was made with respect to the following specific project functions.

SAFETY

No additional activity.

DATA REVIEW

No additional activity.

GEOPHYSICS

No additional activity pertaining to the hydrogeological assessments.

SOIL CORING/ANALYSIS

No additional activity.

INSTALLATION OF WELLS AND LYSIMETERS

No additional activity.

WATER SAMPLING/ANALYSIS (First Episode)

No additional activity.

WATER SAMPLING/ANALYSIS (Second Episode)

No additional activity.

DATA INTERPRETATION/FINAL REPORTS

Received the final survey "tie-in" data from the Hill AFB Civil Engineers which allowed the draft finalization of various report figures. Continued to develop final report figures and text concepts.

PLAN/ADMINISTRATIVE

Becan the "oil slick" and static water level monitoring program at Hill AFB after receiving a verbal go-ahead from the Air Force.

Coordination was completed between UBTL and other contractors with respect to final report details and writing assignments.

APPENDIX J: DATA REVIEW SUMMARIES

(pp. J-1 through J-15)

APPENDIX J: DATA REVIEW SUMMARIES

(pp. J-1 through J-15)

DR-1 Installation Restoration Program, Phase I - Records Search, Hill AFB, Utah; Prepared for United States Air Force AFESC/DEV, Tyndall AFB Florida by Engineering Science, Atlanta, Georgia, January 1982

Engineering Science (ES) was tasked by the Department of Defense to conduct a Hill AFB records search under Phase I of their Installation Restoration Program (IRP). ES conducted interviews with personnel familiar with past waste disposal practices, and file searches were performed to identify base facilities which have generated, handled, transported and disposed of waste materials. The report documented their findings, and various supporting studies and environmental descriptions of Hill AFB. Utilizing the basic information developed, ES applied a numerical rating system to each waste site in order to rank and prioritize the sites for the IRP Phase II problem confirmation and quantification program.

DR-2 An Investigation of Ground and Surface Water Pollution in the Vicinity of the Deactivated Landfill and Burnpit, Hill AFB, Utah, December 1976; Technical Report Number 76-8 USAF Occupational and Environmental Health Laboratory, Brooks AFB, Texas

Based opon a 1976 preliminary survey, it was determined that a field investigation was required to determine if the ground water and/or surface water in the area of deactivated Landfills 3 and 4, Chemical Disposal Pits Nos. 1 and 2, and a burnpit had been contaminated. If so, the investigation was to determine the type and degree of contamination. Fourteen drilled test wells, two surface pools and three seeps were sampled for chemical analysis. Static bioassays were also conducted. The results of the study indicated that contamination of the ground and surface water locally had occurred.

DR-3 Leachate Investigation of the Hill AFB Landfill; prepared for the Department of the Air Force Headquarters, Ogden Air Logistics Center, Hill AFB, Utah by Calscience Research Inc. (CRI), Huntington Beach, California, August, 1981

CRI was tasked by Hill AFB to conduct a field investigation of the Landfill 4 area, in order to provide specific recommendations to alleviate leachate contamination of local ground and surface water. During this investigation 16 existing wells were upgraded and two monitoring wells installed. Also, a series of exploratory soil borings were performed along the southern site perimeter. Water mass balance calculations were computed to estimate possible precipitation and/or ground water underflow contributions to leachate generation. The study determined that concentrations of organics and heavy metals were higher than background counterparts, and that levels of most contaminants exceeded various EPA and state of Utah standards. Based on the results of this investigation, CRI provided mitigation measures recommendations.

DR-4 Aerial Photographs Dated 10/10/71 Provided by University of Utah Research Institute (UURI), Salt Lake City

This series of aerial photographs provided by Dr. Howard Ross (UURI), were from a previous research project at Hill AFB. These photographs were identified as AAK-1mm numbers 161, 162, 163, 164, 165, and 196. These photographs clearly show the waste areas of concern for the present study. They also permitted stereographic analysis of 1971 site details that otherwise would not have been available, particularly the size and locations of chemical disposal pits 1 and 2.

DR-5 Excerpt from the 23 January 1959 Air Force Plan Titled: Master Plan Security, Hill Air Force Base; Hill AFB Civil Engineer, Utah

A selected section of this map of the Berman Pond area was provided. The map depicts topographic contours of the location and elevations at the pond which allowed accurate location of the pond.

DR-6 <u>Aerial Photograph Copy Depicting Monitor Wells Around Landfills 3 and 4, Undated, From the Hill AFB Civil Engineer, Utah</u>

This blue-line aerial photograph copy depicts Landfills 3 and 4, and chemical disposal pits 1 and 2. The copy also shows the locations of the 1976 and 1980 series of monitor wells installed, particularly around the Landfill 4 area.

DR-7 <u>Air Installation Compatible Use Zone (AICUZ) Compatible Use Districts, Hill Air Force Base, Utah, April 1982; From the Hill AFB Civil Engineer, Utah</u>

This map copy depicts designated noise zones throughout Hill AFB, and provides topographic coverage of the waste site locations and surrounding areas at a scale of 1-inch = 2000 feet.

DR-8 <u>Copies of Peterson Brothers Drilling Company Daily Reports of 1980 Series Monitor Wells Formation Description and Casing Data, 1980; Hill AFB, Civil Engineer, Utah</u>

These log copies provided information and data about the geologic materials and water encountered during the drilling of the 1980 series monitor wells. It also provides some information about the well completion materials.

DR-9 <u>Summary Sheet of Depths of Setting of PVC Pipe in the 1980 Series Monitor Wells; Hill AFB, Civil Engineer, Utah</u>

This is a Peterson Brothers Drilling summary tabulation of the depths the monitor well casings were set at in the ground. It also provides some information on the formations and ground water encountered during the drilling.

DR-10 Well Elevations and Water Levels 9 March 1981; Hill AFB Civil Engineer, Utah

This list provides a tabulation of various "W" and "1980" series selected monitor wells measuring point elevations and static water level elevations for 9 March 1981.

DR-11 Water Levels - 24 March 1981; Hill AFB Civil Engineer, Utah

This list provides a tabulation of selected monitor wells ("W" and "1980" series) static water level elevations and changes from a previous measurement.

DR-12 Observation Wells Water Level Elevations 1 May 1981; Hill AFB Civil Engineer, Utah

This is a tabulation of selected monitor wells ("W" and "1980" series) static water level elevations.

DR-13 Observation Wells Water Elevations 14-15 May 1981; Hill AFB Civil Engineer, Utah

This provides a tabulation of static water level elevations for selected "W" and "1980" series monitor wells, which includes some measurements after a rainfall event.

DR-14 Civil Engineer Water Samples (Collected 15 May 1980); Hill AFB Bioengineer, Utah

This is a tabulation of chemical analyses from five sampling points in the area of Landfills 3 and 4. The sampling points were CRI-2, CRI-3, 80-7, 80-13, and 80-23.

DR-15 Chemical Analysis Entitled Sample 5 Results, Undated; Hill AFB Civil Engineer, Utah

This is a tabulation of chemical analyses from samples collected in the Landfills 3 and 4 area. The samples were for CRI-2, CRI-3, CRI-5, 80-7, 8-13, and 80-23.

DR-16 Hill AFB "W" Series Well Information, Undated; Hill AFB Civil Engineer, Utah

These are the notes for the "W" series wells pertaining to the formations and ground water encountered during drilling.

DR-17 Hill AFB Golf Course Irrigation - Season; 15 April to 15 October 1981 and 1982; Hill AFB Civil Engineer, Utah

This provides a tabulation of Hill AFB Golf Course irrigation water in acre-feet consumed.

DR-18 Summary of Effluent Quality: West Spring (Pipe coming out of hill), 1982, Hill AFB Civil Engineer, Utah

This is a tabulation of chemical analysis of samples collected at the West Spring from January through August 1982 which is located downslope of Landfills 3 and 4.

DR-19 Summary of Effluent Quality: East Spring (Next to Perimeter Fence) 1982; Hill AFB Civil Engineer, Utah

This is a tabulation of chemical analyses of samples collected at the East Spring, January through August, 1982 which is located downslope of Landfills 3 and 4.

DR-20 Summary of Effluent Quality: Spring with Water Trough, 1982; Hill AFB Civil Engineer, Utah

This is a tabulation of chemical analyses of samples collected at the spring with water trough, January through August, 1982 which is located in the area of Landfills 3 and 4.

DR-21 Water Level and Measuring Point Elevations, 18 July 1980; Hill AFB Civil Engineer, Utah

This provides for the Landfills 3 and 4 area a tabulation of water level elevations, principally for the "80" series monitor wells. Also included are measuring point elevation survey notes of the monitor wells, which indicates "all elevations good to the nearest 0.1 foot".

DR-22 Tabulation of 33 Well Sample Analyses, 24 June 1980; Hill AFB Civil Engineer, Utah

This is a tabulation of chemical analyses of samples collected during 1980 in the area of Landfills 3 and 4. Samples were collected from the "M", "W", and "1980" series monitor wells, in addition to samples from the canal and West Spring.

DR-23 Preliminary Results of Observation Wells Drilled at Sodium Hydroxide Leak, 1982; Hill AFB Civil Engineer, Utah

This provides a tabulation of pH measurements, with drilling depths, at seven (7) holes in the vicinity of Berman Pond. No geologic descriptions were provided.

DR-24 Copy of News Articles on Release of Phase I of I.R.P., 1982; Hill AFB Bioengineer, Utah

These are four articles from local newspapers noting activities at Hill AFB.

DR-25 Toxicity of Landfill Leachate, 30 June 1982; Department of the Air Force OEHL, Brooks Air Force Base, Texas

This letter summarizes a review of five (5) months of analysis on three leachate springs at the Landfills 3 and 4 area. Sample results, toxicity data and mineral toxicity in cattle were also included at attachments.

DR-26 Master Plan - Basic Layout Pla: Hill Air Force Base, Utah, January 1967; Hill AFB Bioengineer, Utah

This is sheet 1 of 3 (Tab NR C-1) depicting the base facilities and topographic contours around the Berman Pond area, at a scale of 1-inch = 400 feet.

DR-27 Hill Air Force Base - Basic Layout Plan Tab C-2, 30 September 1976; Hill AFB Civil Engineer, Utah

This is a blue-line copy of the base's basic layout plan, with topographic contours. The map shows features at the waste sites, but no waste sites. Scale: 1-inch = 800 feet.

DR-28 Preliminary Refuse Site Repair Plan, 31 March 1982; Department of the Air Force, Ogden Air Logistics Center, Office of Civil Engineering

This map of Landfills 3 and 4 depicts a prospective site repair final contour map. It also includes present contours. Scale: 1-inch = 50 feet.

DR-29 Well Number 1, 2 & 3 and Pumping Stations, Sheet 2 of 2, November 1944, Water Department, Army Air Forces Hill Field Army Air Base; Hill AFB Civil Engineer (WAT-LOGS-44-C), Utah

This provides a graphic presentation of the below ground well construction and geologic formations encountered.

DR-30 Well Number 4 and Pumping Station, Sheet 1 of 1, April 1948 (?), War Department, Army Air Forces Hill Field Army Air Base; Hill AFB Civil Engineer (WAT- Well 4-45-C), Utah

This figure provides below ground well construction and geologic formations encountered at the well site. The well is located southwest of Landfills 3 and 4 and Chemical Disposal Pits 1 and 2.

DR-31 Section 1 - Drill Observation Holes from Invitation for Bids, 1979; Hill AFB Civil Engineer, Utah

This provides the well completion requirements for bidding the drilling of approximately 25 monitor wells at the Landfills 3 and 4 areas. Drilling logs were to be submitted and the drilled holes were to be completed with 4-inch plastic pipe. The monitor wells completed under this contract were the "80" series numbered wells.

DR-32 Lake Bonneville: Geology and Hydrology of the Weber Delta District, Including Ogden, Utah; by Feth, J.H., Barker, D.A., Moore, L.G., Brown, R.J., and Viers, C.E.: USGS Prof. Paper 518, U.S.G.P.O., Washington, 1966, 76p + plates

This report summarizes the geology, especially as related to existing ground water hydrologic conditions in the Weber Delta District in which the Hill AFB is located. The study was conducted by the U.S.G.S. and U.S. Bureau of Reclamation with the assistance of the Utah State Engineer. The report describes the hydrogeologic setting along with principle and minor aquifers.

Ground water in the Weber Delta Subdistrict and a Hill AFB is of the Ca-Mg-bicarbonate type. The Delta Aquifer is the principal source of ground water. This highly permeable aquifer is located 500 to 700 feet below surface throughout much of the subdistrict and varies from about 50 to over 150 feet in thickness. Water quality is adequate for most uses although dissolved Ca and Mg are relatively high. Recharge occurs from the Weber River and along the Wasatch front.

Less significant aquifers include the Sunset Aquifer and the shallow aquifers underlying the areas of Roy and Syracuse, northwest and southwest of Hill AFB, respectively. The Sunset Aquifer generally lies 250 to 400 feet below surface and varies from 50 to 200 feet thick. Water quality is similar to that of the Delta Aquifer, but permeability is considerably lower.

Ground water in the shallow aquifers is more highly mineralized than those of the Delta and Sunset Aquifers. Near Roy, the shallow and deep aquifers are not thought to be hydraulically connected. However, in the Syracuse area, pressure relationships suggest the aquifers may be linked by upward leakage.

DR-33 Geothermal Exploration Program - Hill Air Force Base, Davis and Weber County, Utah; by Glenn, F.E., Chapman, D.S., Foley, D. Capuano, R.M., Cole, D., Sibbett, G., and Ward, S.H.; Prepared for U.S.D.O.E./Division of Geothermal Energy, by Earth Science Laboratory, UURI, Salt Lake City, March, 1980

This report summarizes the results of a phased exploration program designed to determine whether an exploitable geothermal resource exists beneath Hill AFB. The program included a review of available geological data, regional exploration, and emplacement of two thermal gradient holes. The primary exploration targets were faults that might be part of convective hydrothermal systems; the secondary targets were stratigraphic aquifers.

Gravity profiles and reflection seismic surveys were used to delineate faults and determine depths to bedrock. Thermal gradient holes were drilled on the east and south sides of the base to depths of 1280 feet and 3269 feet respectively. Measured temperatures (55°F and 104°F, respectively) were lower than expected based on the prevailing regional gradient.

The major conclusion of the study is that a shallow geothermal resource does not underlies Hill AFB.

The geothermal well data provides geologic information at the areas of waste disposal sites, Berman Pond and Landfills 3 and 4. Structural data provided in the reports indicates that the Hill AFB golf course area may be a structurally high area due to faulting.

DR-34 Hill Air Force Base Utah - Environmental Protection Report 1981: Air Force Logistics Command, Ogden Air Logistics Center

This report presents a synopsis of the environmental aspects of Hill AFB and the surrounding area, as well as an evaluation of past and current environmental protection practices, programs, and accomplishments. The environmental setting is described with respect to climate, geology, and hydrology.

Control systems/programs designed to alleviate pollution of the air and water, and environmental degradation resulting from noise, radiation, solid wastes, and toxic or hazardous wastes are presented. Environmental R&D, enhancement, and education/training programs conducted by the base are outlined.

The status of the Installation Restoration Program is presented which includes a ranking of potential contamination sources resulting from past disposal practices, and description of current and planned measures to mitigate adverse impacts. Landfill 4 and Chemical Disposal Pits 1 and 2, respectively, received the highest priority rankings based on potential hazardousness. At report issuance, leachate monitoring of the landfill and arrangements for provision of an alternate water source during landfill restoration had been accomplished. Additional monitoring at lower priority sites was planned for 1982.

DR-35 Tab A-1. Environmental Narrative, Hill Air Force Base, Utah, 18 March 1977; 15 March 1978 Revised; RCS: HAF-PRE(AR) 7801

This report describes the environmental, historical, geographical, and operational aspects of Hill AFB. Environmental descriptions include citations to reference literature. Specific areas of the base and their use with respect to operations conducted, housing, etc. are presented in some detail.

DR-36 Report of Soil Tests - Hill AFB Squadron Flight Operations Building: Department of the Army, South Pacific Division, Corps of Engineers Laboratory, Sausalito, California, August, 1982

This report summarizes the results of tests made on 12 undisturbed core samples and 18 plastic bag samples recovered from the vicinity of the Flight Operations Building near Berman Pond. Tests conducted include grain size analysis, triaxial compression, consolidation and moisture content, Atterberg limits and standard soil classification.

DR-37 Soil Boring Logs Provided by Mel Howell, Department of the Army, Sacramento District, Corps of Engineers, to Rick Belan, 30 November 1982

Shallow borings (≤20 ft. TD) were made in the vicinity of the Squadron Operations Building (3 borings) and the Depot Armament/Ordnance/ Weapons Ship (18 borings). These facilities are located near Berman Pond, so that the soil data may be extrapolated to reflect conditions of the soils underlying the abandoned waste lagoon.

Boring logs indicate that the soils in both areas are dominated by fine to very fine grained sand and silt. Other lithologies are reported, but they are relatively minor.

DR-38 Log of Mountain Fuel Supply Co. Well No. 1, Sunset, Utah: Utah Field Area, U.S. Engineer Office, Hill Field, Ogden, Utah, 5 March 1941 (WAT-MF Well-41-C)

This log of Mountain Fuel Supply Well No. 1 provides descriptions of major lithologic units encountered from surface (elev. = 4730 feet) to a total depth of 554 ft. 10 in. Thicknesses of individual units are also reported. The log indicates that at the time the well was drilled (3/5/41) ground water was encountered at a depth of 417 feet.

DR-39 Drilling Water Well No. 4 - Log of Existing Wells; U.S. Engineer Office, Salt Lake City District, Ogden Air Depot, Hill Field, Ogden, Utah, 17 June 1943 (WAT-LOGS-43-C)

Lithologic logs from five wells existing at Hill Field prior to drilling of Well No. 4 are provided, along with the log of the new well (No. 4). Existing wells are identified as an abandoned well; well no's. 1, 2, and 3; and the Ogden Ordnance Well. In addition to major lithologic subdivisions, all logs show surface and bottom hole elevations, casing diameters, and perforated zones. Water level elevations are indicated for all but the abandoned well. Most of the wells are located north of Chemical Disposal Pit No. 3 while Base Well No. 4 is in the vicinity of Landfills 3 and 4 and Chemical Disposal Pits Nos. 1 and 2.

DR-40A&B <u>Detailed Utility Map, Hill Field, Ogden, Utah, Sheets 2 and 3: War Department, Army Air Forces, Ogden Air Service Command, Post Utilities Office (Sheet 2 - last revision dated 25 April 1968; Sheet 3 - last revision dated 12 March 1971)</u>

These maps show the locations of utility lines with respect to Base facilities and roads in the vicinity of Berman Pond and which depicts a sanitary sewer drain in the vicinity of Berman Pond. Map scale is 1-inch = 50 feet.

DR-41A&B <u>Ogden Air Material Area, Master Plan Sanitary Sewer System, Hill Air Force Base, Utah, Sheets 1 and 2: Department of the Air Force, Asst. Chief of Staff/Installations-Washington, D.C., January 1967</u>

These maps show the locations of sanitary sewer mains and manholes located in the areas south and southwest of Landfills 3 and 4 and Chemical Pits 1 and 2. Map scale is 1-inch = 400 feet.

DR-42 <u>Ogden Air Logistics Center, Master Plan, Storm Drainage System, Hill Air Force Base, Utah, Sheet 2: Department of the Air Force, Asst. Chief of Staff/Installations - Washington, D.C., September 1981 (latest revision)</u>

This map shows the storm drainage control system elements located in the northeast portion of Hill AFB. This area includes Landfills 3 and 4 and Chemical Pits 1 and 2. The information presented will aid in assessment of possible environmental pathways associated with run-on/run-off at the disposal sites. Map scale is 1-inch = 400 feet.

DR-43 Topographic Map of the Karpville Quadrangle, 7.5 Minute Series, Davis Co., Utah (scale = 1:24,000; contour interval = 40 feet): U.S. Department of the Interior, Geological Survey/Department of the Army, Corps of Engineers, 1955 (photorevised 1969, 1975)

This map shows the surface relief, physiographic and man-made features, and population centers southeast of Hill AFB, located in the northwest part of Karpville Quadrangle.

DR-44 Topographic Map of the Ogden Quadrangle, 7.5 minute series, Utah (scale = 1:24,000, contour interval = 40 feet): U.S. Department of the Interior, Geological Survey/ Department of the Army, Corps of Engineers, 1955 (photorevised 1969, 1975)

This map shows the surface relief, physiographic and man-made features, and population centers northwest of Hill AFB, located in the southeast part of Ogden Quadrangle.

DR-45 Environmental Geology of the Wasatch Front, 1971: Utah Geological Association, Publication 1, Utah Geological and Mineralogical Survey, Salt Lake City, Utah

This publication consists of a series of papers addressing the geologic and hydrologic setting of the Wasatch Front, and resultant regional and local environmental consequences.

Geologic structures/features having particular environmental significance include faults and associated seismic activity; landslides (including rock slides, slumps, and earthflows); and soil and rock failure. Hill AFB Chemical Disposal Pit No. 3 is located in the slump complex described in the report. The southern portion of the slump complex may impact hydrogeologic conditions at Chemical Disposal Pits Nos. 1 and 2.

APPENDIX K: SAFETY PLANS
(pp. K-1 through K-19)

- Geophysics Safety Plan (ESL/UURI)
- Hydrogeology Safety Plan (Radian Corp.)
- Laboratory Safety Plan (UBTL/UURI)

APPENDIX K: SAFETY PLANS

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K.

SAFETY PROGRAM

Project: Hill AFB Hazardous Waste Study, Phase II

Task: Electrical Resistivity Surveys for Waste Pit Delineation

Subcontractor: Earth Science Laboratory, University of Utah Research Institute

I. WORK DESCRIPTION

The work to be performed is electrical resistivity surveys of waste landfill areas and chemical waste disposal pits. A gasoline powered motor generator is used to produce electric current which is transmitted to metal stakes (electrodes) which are in contact with the earth. A voltage drop is observed at varying distances from the transmitting electrodes through a digital voltmeter or receiver. The field crew, typically three men, and all equipment, are typically transported in pickup trucks, surburban vehicles, or vans.

II. POTENTIAL WORK HAZARDS AND SAFETY CONSIDERATIONS

The following are recognized as work activities which may result in accidents:

1) Transportation from ESL/UURI to Hill AFB (vehicle accident)
2) Transportation on Hill AFB
3) Lifting equipment (current transmitter, motor generator, water cans)
4) Preparing electrodes (digging with entrenching tools, pounding aluminum stakes with sledge hammers)
5) Transmitting electric current (potential shock hazard at electrodes and transmitter terminals)
6) Preparing electrical wires (possible cuts)

7) Working along roadsides and near base exercise areas.

8) Handling gasoline cans for refilling the motor generator.

III. PERSONNEL

A. Only physically and mentally qualified personnel with related field experience will be used for this work.

B. All drivers will have a valid Utah Drivers License.

C. Personal clothing standards will be enforced. At a minimum these listed below are the requirements:

1. Short sleeve shirt
2. Long trousers
3. Leather boots or work shoes or other appropriate protective shoes or boots. Canvas shoes, tennis or deck shoes are not acceptable.
4. Hard hats will not be required since this is not a construction activity and will not take place in construction areas.

IV. ACCIDENT PREVENTION RESPONSIBILITY

A. The field crew chief or geophysicist in charge on the site will be the job site safety officers, and will be responsible for crew safety.

B. Earth Science Lab/UURI personnel will cooperate fully with government personnel in evaluating job hazards and maintaining a safe jobsite.

C. All personnel will be familiar with the location of the base hospital, Building 570, which is located near some of the job site areas.

V. SAFETY MEETINGS

A. All personnel will read and maintain a copy of this Safety Program.

B. All personnel will be instructed as to avoidance of recognized hazards prior to beginning the work on the jobsite.

C. Safety meetings will be held to identify and evaluate possible hazards and problems before each new phase of work, and every Monday morning.

VI. SUBCONTRACTORS

A. No subcontractors will be used in this work.

VII. SANITATION

A. Drinking water will be provided from local culinary sources and dispensed from insulated jugs.

B. Every effort will be made to establish and maintain sanitary job conditions. This is facilitated by using existing base facilities.

VIII. FIRST AID AND MEDICAL FACILITIES

A. A first aid kit will be available at the crew vehicle at all times.

B. Personnel requiring emergency treatment will be transported to the Hill Air Force Base Hospital, because of its proximity, if the injury requires treatment at this level.

IX. PUBLIC PROTECTION

All necessary precautions will be taken to protect the public from hazards arising out of the project. High voltage areas will be identified with appropriate DANGER signs.

X. HOUSEKEEPING

A. Project equipment will be restricted to the immediate area of a single field site away from vehicle and pedestrian traffic.

B. Electrical wires, survey stakes, etc. will be picked up promptly upon the completion of each portion of the work.

XI. GASOLINE

Gasoline will be stored and dispensed from heavy duty MS 5 gallon fuel cans.

XII. ACCIDENT REPORTING

A geophysicist or crew chief will be at the work site at all times and will be immediately informed of any accident. He will determine the severity level of the accident and dictate the immediate action (hospital, local doctor, first aid, etc.). Any lost time accident or accident requiring professional treatment will be reported to Hill Air Force Base authorities within two hours. Accident reporting and investigation will be in strict compliance with established Hill Air Force Base proceedures.

Howard P. Ross

Howard P. Ross, Ph.D.,
Senior Geophysicist, ESL/UURI

Sim D. Lessley

Sim D. Lessley, Ph.D.
Technical Manager, UBTL/UURI

RADIAN
CORPORATION

M E M O R A N D U M October 26, 1982

TO: Sim D. Lessley, Ph.D., Technical Manager - UBTL

FROM: R. Vandervort, R.A. Belan - Radian Corporation

SUBJECT: Safety Plan for IRP Investigations at Hill AFB, Utah

I. PURPOSE

The purpose of this plan is to describe and establish minimum safe work procedures and practices for the accomplishment of IRP investigation work to be conducted at inactive waste disposal sites located on Hill AFB, Utah property. The plan is intended to apply to Radian Corporation (hereafter "Radian"), subcontractors to Radian, and employees of other firms working under the technical direction of Radian at the various waste disposal sites.

II. ACCIDENT PREVENTION RESPONSIBILITY

The prime responsibility for employee safety shall rest with: (1) Radian for its own employees, (2) Radian subcontractors for their employees and, (3) with other firms whose employees will work under Radian's technical direction on-site at Hill AFB, Utah.

Radian, its subcontractors, and other firms participating in onsite work, will comply with all applicable requirements of the Utah Occupational Safety and Health Rules and Regulations. These parties will also cooperate with government safety and health personnel with respect to project work.

III. OBSERVANCE OF HILL AFB REGULATIONS

Radian and its subcontractors will observe and cooperate with all Base regulations regarding access, vehicle operation, personal conduct, etc. while on Base. Specifically: (1) all personnel will obtain passes to enter Base property and will check in and out through Base guard stations, (2) all vehicles used onsite will carry current registration and inspection information, and (3) all vehicle/equipment operators will carry valid driver/operator licenses.

IV. SUBCONTRACTS

This safety plan will be an addendum to all subcontracts initiated by Radian. The addendum will require compliance with the program.

V. SANITATION

Drinking water will be obtained from local culinary sources and dispensed from cooler cans and disposable paper cups. Every effort will be made to establish and maintain sanitary job conditions.

VI. FIRST AID AND MEDICAL FACILITIES

Radian and its subcontractors will have available first aid kits for treatment of minor injuries. Because of the close proximity of the Hill Air Force Base Hospital, persons requiring emergency treatment will be transported to that facility.

VII. SAFETY PRECAUTIONS

Safety training, protective clothing and equipment, and work practices which will be required of Radian employees and its subcontractors are described in sections 1.0 and 2.0 of "SAFETY PRECAUTIONS" attached hereto.

VIII. ACCIDENT REPORTING

Accidents will be reported within one hour. All required accident report forms (Utah and U.S. Government) will be promptly completed.

SAFETY PRECAUTIONS

1.0 COLLECTION AND HANDLING OF SOIL CORES AND/OR DRILLING SAMPLES

1.1 Hand Augering

Shallow depth core samples will be collected from several areas suspected to overlay waste disposal sites. A hand augering device will be used to collect soil core samples for subsequent laboratory analysis. The following safety precautions will be observed when collecting hand augered core samples.

1.1.1 Safety Training

Persons designated to perform hand auger soil sampling will be instructed regarding the potential health and safety hazards associated with the work prior to commencing field activities. Specifically, the following topics will be covered in the training session:

- o Potential routes of contact with toxic and/or corrosive substances
    - skin contact/adsorption
    - eye contact
    - inhalation
    - ingestion

- Types, proper use, limitations and maintenance of applicable protective clothing and equipment

  - safety helmet
  - chemical goggles
  - impervious/chemical resistant gloves
  - impervious/chemical resistant/safety-toe boots
  - impervious body coverings (aprons, blouse, trousers)

- Respiratory protection using half-facepiece air purifying respirator with replaceable filter cartridges

  - Hierarchy of protective controls: engineered, administrative, work practice, personal protective clothing and equipment.

  - Forms of respiratory protection: air purifying (disposal/reusable), air supplied, self contained.

  - Selection of respiratory protection based on hazard: dust, fume, mist, gas, irritant, poor warning properties.

  - NIOSH certification/approval of respiratory protection equipment.

  - Medical/physical fitness to wear respiratory protection.

- Reevaluation of respirator selection.

- Use, limitations and maintenance of half-facepiece air-purifying respirator: qualitative fit test, routine inspection, replacement of parts, cleaning/disinfection, storage.

o Reporting of accidents and availability of medical assistance.

1.1.2 Protective Clothing and Equipment

All hand augering work will be performed by persons garbed in the following minimum protective items:

o Gauntlet style, chemical resistant/impervious gloves
o Safety toe, chemical resistant/impervious boots
o Chemical eye goggles

Depending on soil core properties, site conditions and weather, other items may be used for supplemental protection. Such items may include:

o Safety helmet
o Respirator (half-facepiece, air-purifying)
o Impervious apron
o Impervious work blouse and/or trousers

1.1.3 Work Practices

1.1.3.1 Sampling Activities

All core activities will be conducted by persons wearing at least the minimum protective items listed above. Field personnel will stand upwind from the auger location and upwind from extracted samples during their handling.

Odorous soil cores or site conditions will result in donning of organic vapor/acid gas respiratory protection. Similarly, dusty site or soil core conditions will result in donning particulate filter type respirators.

Soil cuttings from hand augering which display contamination will be removed from the site in suitable sealed sample containers or other sealed container for eventual disposal, or placed back into the hand augered hole.

Gloves, boots, sampling equipment will be rinsed with clean water at the site. After rinsing, gloves, boots, etc. will be placed in clean bags for transportation to an area where they can be thoroughly cleaned with detergent and water.

1.1.3.2 Equipment, Personal, Site Hygiene

Punctured, internally contaminated, cracked, stubbornly soiled, protective items will be disposed in sealed plastic bags.

Paper, rags, and other disposables used on site or in equipment/sample container clean up will be disposed of in sealed plastic bags.

No food will be consumed on the exploration site. Employees will thoroughly wash their hands, forearms and face before consuming food or beverages other than water held in disposable cups. Drinking water will be available at the perimeter of the site being investigated. Disposable cups will be used to consume water after protective gauntlet gloves are removed.

1.2 Drill Cutting Sampling

Periodically, drill cutting samples may be collected from either shallow or deep drilling activities. A bucket and/or impermeable plastic sheeting will be used to collect drill cutting samples from the air discharge line for subsequent laboratory analysis. The following safety precautions will be observed when collecting drill cutting samples.

1.2.1 Safety Training

(Same as in Section 1.1.1)

1.2.2 Protective Clothing and Equipment

All drilling sample collection will be performed by persons garbed in the following protective items:

- o Gauntlet style, chemical resistant/impervious gloves
- o Safety, chemical resistant/impervious boots
- o Chemical eye goggles
- o Respirator (half or full piece, air purifying)*
- o Impervious work blouse and trousers*

*Note: Depending upon the actual field conditions encountered, these may not be necessary. (i.e. if air discharge is shut off before and after sample collection if using a static collection method.) The on-site Radian representative will stipulate the form of respiratory protection required.

Depending upon soil properties, site conditions and weather, other items maybe used for supplemental protection. Such items may include:

- Safety helmet
- Face Shield
- Impervious apron
- Impervious pant and jacket

1.2.3 Work Practices

1.2.3.1 Sampling Activities/Care of Protective Items

All drill cutting sampling activities will be conducted by persons wearing at least the minimum protective items listed above (sec 1.2.2). Field personnel will stand upwind from the discharge line and upwind from the extracted cutting during their handling.

Odorous soil cores or site conditions will result in donning of organic vapor/acid gas respiratory protection. Similarly, dusty site or drill cuttings will result in donning particulate filter type respirators.

Gloves, boots, other protective coverings and sampling equipment will be rinsed with clean water at the site before eating, drinking and at the conclusion of each days drilling activities. Respirators, if worn, will be used during the rinse down activity.

Where visual observation of cutting or detected odors show contamination, personal protective items, will be placed in clean bags after rinsing for transportation to an area where they

can be thoroghly cleaned with detergent and water and inspected for leaks, cracks or other damage. Where only clean cuttings are present, protective items will be rinsed, inspected, dried and otherwise made ready for reuse. Respirators will be thoroughly cleaned, disinfected and repaired after each use.

Drill cuttings which display odor or visual contamination will be sampled for laboratory chemical analysis. Ultimate disposal of the cuttings will be based on chemical analyses. The estimated cutting volume for the 6-inch wells of about 30 feet depth would be on the order of approximately 6 cubic feet.

2.0 DRILLING ACTIVITIES

2.1 Drilling Personnel

The driller and support personnel will be responsible for the procurement, safe use and proper maintenance of personal protective safety equipment (except respirators) that maybe required during drilling, construction and development of monitor wells. The following safety precautions as a minimum will be observed when operating the drilling rig at an exploration site.

2.1.1 Safety Training

(Same as in Section 1.1.1)

2.1.2 Protective Clothing and Equipment

All active drilling work during the time of air discharge will be performed by persons garbed in the following minimum protective items.

- o Gauntlet style, chemical resistant/impervious gloves
- o Safety tce, chemical resistant/impervious boots
- o Chemical eye goggles
- o Impervious work blouse and/or trousers
- o Safety helmet
- o Respirator (half-face, or full face, air purifying)

Depending on drill cutting properties, site conditions and weather, other items maybe used for supplemental protection. Such items may include:

- o Impervious apron
- o Face shield

2.1.3.1 Drilling Activities

All drilling activities during the period of bit cutting and air discharge will be conducted by persons wearing at least the minimum protection items listed above in Section 2.1.2. During static conditions, consistent with safe practices the respirator and possibly the goggles may not be warranted for rig functions (i.e. casing welding, uncontaminated casing handling, etc.), or drilling into uncontaminated zones below shallow contaminated zones. Drill cuttings with unnatural odor or obvious visual contamination will require that organic vapor/acid gas respiratory protection be worn until cuttings are covered (see Section 2.1.3.3) and the rig is washed down. Similarly very dusty site or cutting conditions will particulate filter type respirators be worn until cuttings are enclosed and the drill rig washed down.

Field personnel and the rig will be oriented upwind as much as practical from the airline discharge. An extra long discharge line will be provided that can be moved depending on wind conditions.

Gloves, respirators, goggles, boots, drilling equipment and exposed casing will be rinsed with clean water at the site as a minimum at the end of each days activities. Gloves, boots, drilling equipment casing will also be rinsed between the sites (Chemical Pits 1 & 2, Landfill #3, Chemical Pit #3 and Berman Pond.) depending on site conditions, and individual monitor wells. The drill bit and stem(s) will be rinsed when continuing to drill deep monitor wells or below the top clay (~30 feet down) at the sites.

Care of protective items will be as stated in Section 1.2.3.1.

2.1.3.2 Personal/Site Hygiene

Punctured, internally contaminated, cracked, stubbornly soiled, protective items will be disposed in sealed plastic bags.

Paper, rags, and other disposables used on site or in equipment/sample container clean up will be disposed of in sealed plastic bags.

No food will be consumed on the exploration site. Employees will thoroughly wash their hands, forearms and face before consuming food or beverages other than water held in disposable cups. Drinking water will be available at the perimeter of the site being investigated. Disposable cups will

be used to consume water after protective gauntlet gloves are removed.

2.1.3.3 Cuttings Containment

All rotary drill cuttings will be discharged onto a heavy polyethylene sheet spread over the ground. At the conclusion of drilling the plastic sheeting will be folded up over the cutting pile. As necessary, a top covering of plastic sheeting will be used to complete enclosure of the cuttings. Rocks or other heavy objects will be used to secure the plastic sheeting. The plastic sheeting will control leachate formation and erosion. Final disposal of the cuttings will be determined by their chemical analysis.

UBTL LABORATORY SAFETY PLAN FOR HILL AFB SURVEY

I. Purpose

The purpose of this safety plan is to summarize the procedures that will be used by UBTL to accomplish the sampling and analysis work connected with the Hill AFB Survey. The UBTL Chemistry Department Safety Manual describes the laboratory safety program in detail. A copy is available upon request.

The laboratory anticipates the sampling and analysis of contaminated soil and water. The volume of each sample will be one liter or less. Preliminary investigations suggest that the samples will not represent a high hazard to laboratory personnel. Accordingly, a safety program for the handling of small volumes of moderately hazardous soil and water is proposed. Additional safety measures will be taken as necessary.

II. Policy

The laboratory's safety policy is to take every reasonable precaution in the performance of work to protect the health and safety of employees and of the public and to minimize the possibility of damage to property. OSHA regulations, national and state protection guides, safety codes, etc., are used wherever they apply. Where no standard safety procedure exists, an appropriate procedure will be developed.

III. Protective Clothing

A. At a minimum, all personnel who work in the laboratory will wear a laboratory coat and safety glasses.

B. Personnel who handle the bulk samples will wear vinyl gloves in addition to a laboratory coat and safety glasses. Face shields, goggles, gauntleted gloves, impervious aprons, and disposable coats will be available.

IV. Safety Equipment

A. An absorbent, impervious cover will be placed on any working surface used for working with bulk samples.

B. Odorous or dusty bulk samples will be handled in a fume hood.

C. Explosion shields, fire extinguishers, eyewash stations, emergency shower and personal respirators will be available.

V. Accident Prevention Responsibility

A. The safety program is the responsibility of the Chemistry Department Director. It is administered by the Laboratory Supervisor who reports to the Department Director.

B. A safety committee composed of laboratory workers and administrative personnel conducts independent safety reviews and submits their findings and any suggestions to the Department Director.

C. Instruction in safe laboratory practices is the responsibility of the section managers and the first-line supervisors (group leaders) who report to them.

D. The implementation of safe practices is the responsibility of each laboratory worker and his group leader.

VI. First Aid and Medical Facilities

A. A first aid kit is maintained in a central location at the laboratory.

B. The University of Utah Medical Center emergency room is located within one mile of the UBTL building. Persons in need of emergency care will be taken to that facility.

VII. Housekeeping

A. Samples and sample extracts will be identified and stored in designated areas prior to release for disposal.

B. Solvents will be stored in ventilated cabinets approved for flammable liquid storage. Stocks of laboratory chemicals will be stored in ventilated cabinets.

VIII. Instrument Maintenance

Laboratory instrumentation will be maintained in a safe, functional condition by vendors under service contracts or by laboratory personnel.

IX. Sample Handling

A. Laboratory personnel involved in sampling will work under the technical direction of Radian Corporation personnel. Safety equipment will be provided by Radian Corporation and the practices outlined in the accompanying Radian Corporation safety plan will be followed.

B. The splitting of samples for analysis will be performed on a work surface covered with an absorbent material backed by an impervious plastic film. Odorous or dusty samples will be split in a fume hood.

C. Sample extracts will be handled in a manner appropriate for their composition. Containment of spills will be provided for acid extracts. Organic solvent extracts will be prepared and transferred in a fume hood.

D. Disposal of samples and extracts will be carried out in accordance with their composition as determined by chemical analysis.

X. Accident Reporting

Accidents involving samples from the Hill AFB Survey will be reported within 2 hours.